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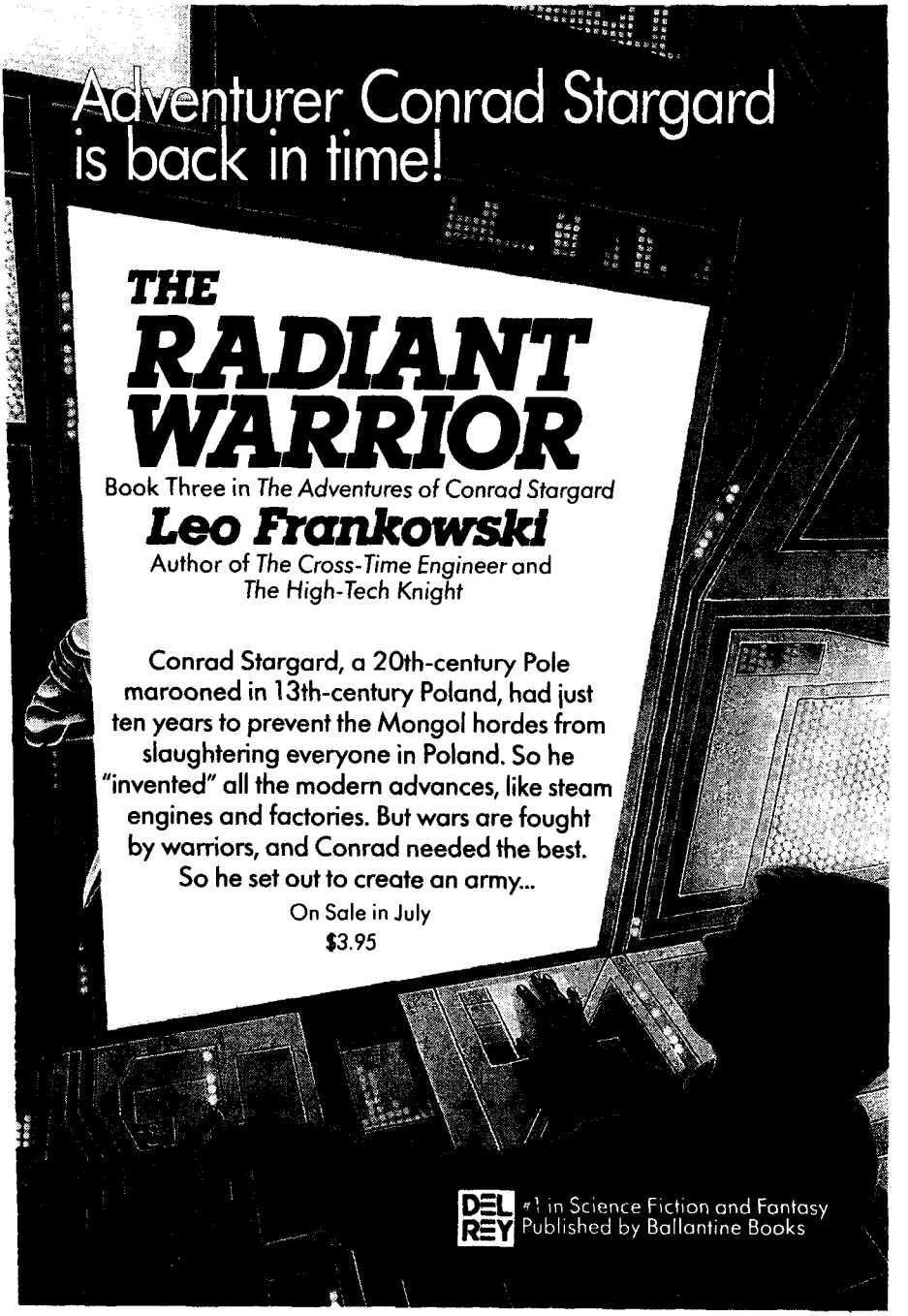
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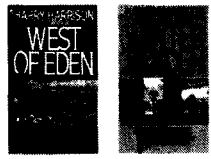

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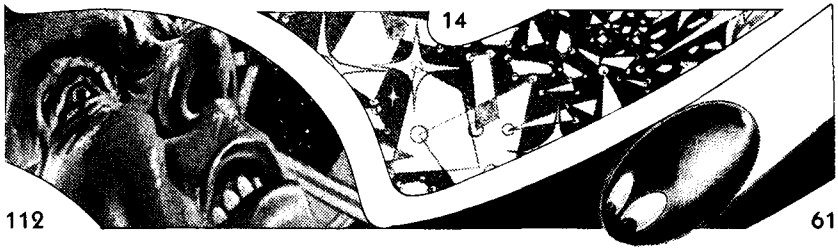

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Guest Editorial

THE EITHER/OR FALLACY

Ben Bova

Should the major objective of the United States in space be Mars or the Moon?

Should Americans support NASA's plan to construct a permanently manned space station or instead support the privately funded Industrial Space Facility, which is to be visited by astronauts rather than staffed continuously?

Should we continue manned space flight at all, or concentrate on unmanned scientific probes of the Solar System?

Those are three prime examples of the Either/Or Fallacy.

I define the Either/Or Fallacy as a frame of mind that falsely assumes two goals to be in conflict with one another. In the hands of a cynical politician, the Either/Or Fallacy can be a nasty weapon indeed. It's a sort of latter-day version of the hoary, "Are you still beating your wife?" No matter how you answer, you're in the wrong.

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Almost since the inception of the U.S. space program, in the late 1950s, the Either/Or Fallacy has been used by politicians to befuddle the public and to stymie space enthusiasts. In the 1960s and '70s its most common form was: "Shall we push on with the exploration of space or feed the poor?"

See the trick? If you say that you want to feed the poor, then you've admitted that we should not push the exploration of space. If you say you want to do more in space, you're showing the world that you don't care about the needy.

For decades the politicians in Washington have very cleverly maneuvered the U.S. space program into this "either/or" corner. Its latest manifestations are:

Either we allow NASA to build its $25 billion manned space station *or* we go instead with a privately-developed Industrial Space Facility that is mantended but not permanently occupied.

Either we make Mars our major objective in space *or* we make a return to the Moon the prime focus of the space program.

The damnable thing about the Either/Or Fallacy is that it can be so subtle that most of the people who strongly want to move ahead in space, people such as the readers of this magazine, can often fall prey to it. We space enthusiasts argue among ourselves about the values of manned space flight as opposed to unmanned missions to the planets as if we actually were faced with an either/or situation.

Which is nonsense.

We know the answer to the *either* space *or* the poor conundrum: space feeds the poor. Our investment in space technology has created more jobs and real wealth in the U.S. economy than all the welfare programs since the end of World War II.

Studies have shown that space-derived industries such as space transportation and payload processing, satellite communications, satellite remote sensing, low-gravity materials research and processing have been growing at an average rate of 18% per year, and now generate some $50 billion per year for the U.S. gross national product. In another decade they will bring more than $70 billion annually into the American economy.

That means jobs, by the millions. And not merely jobs for the engineers, but for their butchers and bakers and telescope makers as well. For their real estate agents and babysitters and appliance salesmen. For the truck drivers and computer programmers and all the service personnel in their communities.

When it is brought out into the open and we stop to think about it, most of us realize quite easily that the Either/Or Fallacy truly is a fallacy, a false assumption built on false premises.

Yet the politicians, wielding the Either/Or Fallacy, have arranged things so that the space enthusiasts often spend most of their energy battling each other, rather than fighting the real enemy.

Back almost at the beginning of the U.S. space program the politicians figured out a dandy way to use the Either/Or Fallacy to "keep the space nuts in line." It's so simple that it goes virtually unnoticed, even though it is out there in plain sight all the time.

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Very simply, the politicians—in the White House, the Office of Management and Budget, the Congress, the Office of Technology Assessment, and elsewhere—they set an arbitrary figure for the space budget each year. Nowadays, with thirty years of experience behind them, they usually pick a number for the NASA budget that is some percentage above or below the previous year's budget number.

The number is picked and proposed as part of the White House's overall budget for the coming fiscal year. On Capitol Hill the number is massaged, whittled down, occasionally increased slightly.

Space enthusiasts march down to Washington to support the number. They write their congressional representatives and senators. They start telephone campaigns to save certain pro-

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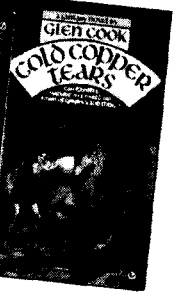
Old Tin Sorrows

BY

Glen Cook

It all starts when Garrett's old sergeant calls in a wartime debt. This time he's up against ghosts, ghouls—and an unstoppable dealer in death. Everyone around him seems to be ending up dead... and they've just missed adding Garrett to this corps of corpses. With the toughest half-elf around to guard his back, Garrett has to get his hands on the killer—while two invisible beauties try to get their hands on him!

And be sure to pick up these other books in the Garrett Files



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grams threatened by a congressional reduction of the number.

Divide and conquer. This budget process rams the Either/Or Fallacy down our throats! The politicians stand back and watch the space enthusiasts fight over who gets what share of a space budget that is always too small to do all the things that need doing.

That is why, in the past, those in favor of planetary exploration have fought against manned space flight. Why some academic scientists referred to the Apollo program as a "Moondoggle." That is why NASA presented the shuttle to Congress, back in the early 1970s, as the only launching vehicle we would need, so that when *Challenger* exploded there was no fleet of expendable boosters capable of taking up the slack until the remaining shuttles started flying again.

That is why, today, many scientists oppose the space station program: they want the money spent on *their* efforts instead.

They tacitly assume that the space budget is fixed by heavenly decree at a certain level, and they must fight for their share of that budget. What is spent on the space station cannot be spent on space science. Either/Or. Divide and rule.

Thus the Either/Or Fallacy leads members of the space community to fight among themselves while the politicians sit back and laugh up their sleeves. The people who want to expand the human race's habitat throughout the Solar System and beyond, must squabble and scratch for crumbs from the table when, in fact, they have produced the grandest banquet that the human race has ever known: the wealth of the entire Solar System, at our fingertips.

There is a better way to handle the government's funding of space.

But before discussing what that better way is, we ought to ask ourselves why the politicians have saddled our space efforts with the Either/Or Fallacy.

It's not that the politicians are inherently evil. Short-sighted, yes. But not really evil. Politicians in a democracy behave somewhat like a particle of soot in Brownian motion: they move in the direction dictated by the forces hitting them. All sorts of pressure groups are constantly hitting the politicians to *do* this, and *spend* more tax money on that. Some politicians even try, now and then, to follow the dictates of their own beliefs and ideals!

Space enthusiasts try to pressure the politicians to do and spend more on space. But the space enthusiasts do not have the clout of, say, the National Rifle Association or even the Sierra Club. *And most politicians simply do not know, and do not believe, that space is important.*

Most politicians still see space as a luxury, a scientific adventure, an avenue for international prestige. Something that's nice, if you can afford it, but certainly not as vital to the nation's interests as defense, or crime, or welfare.

They do not see the connection between the advances we make in space technology and the strength of the U.S. economy. In an era where the old smokestack industries have nearly collapsed under the pressure of interna-

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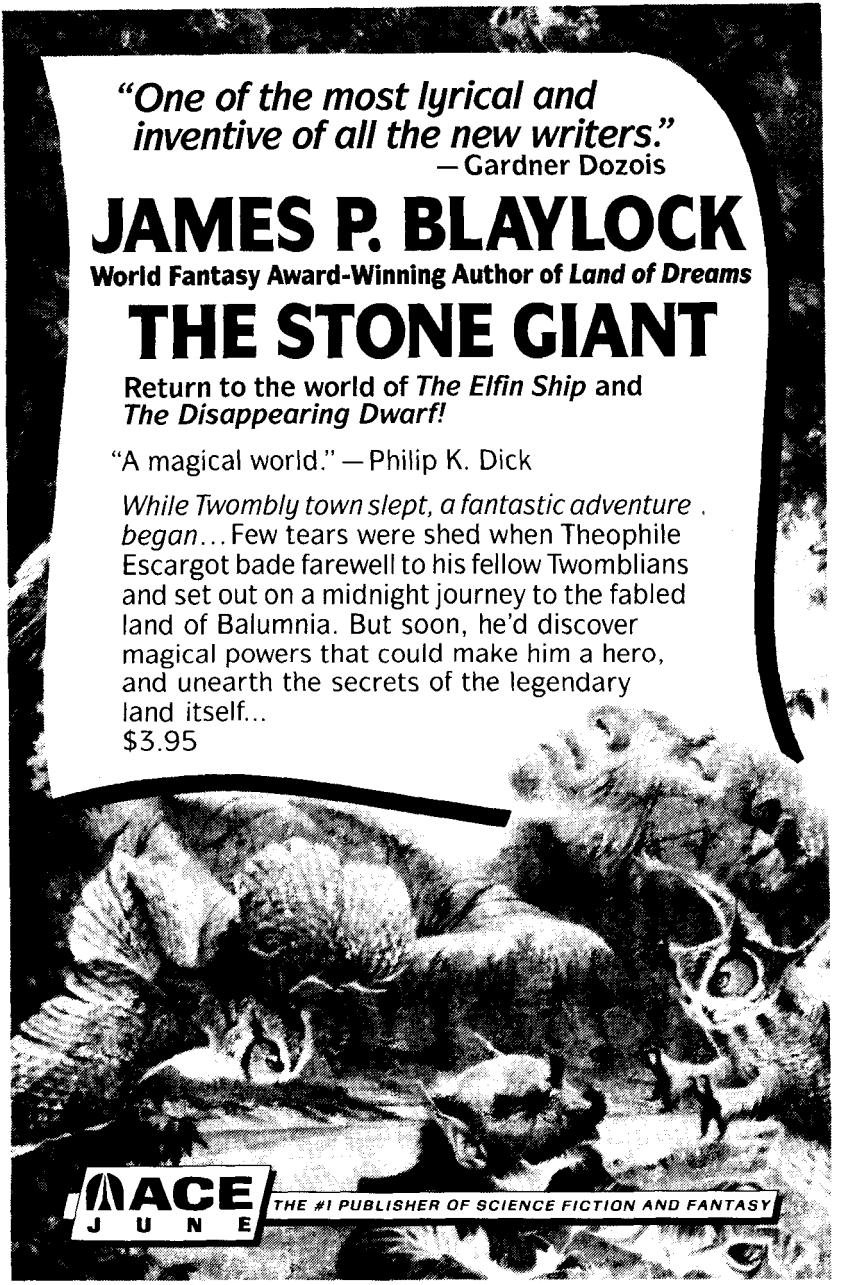

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tional competition, where Japan and other nations are outdoing us in everything from automobiles to copying machines, our politicians do not understand that space technologies offer the main hope for the American economy over the coming decades.

That is why they can blithely pick an arbitrary number for the space budget and let the chips fall where they may. If space were as important to them as Social Security, we'd be holding dances every Saturday night on Mars.

So here is my modest suggestion for breaking the Either/Or Fallacy and funding our space efforts at a level commensurate with our goals and our resources.

First, determine how much space-derived technology puts into the U.S. gross national product each year. A few paragraphs above we saw that $50 billion per year is the *current* payback from space industries, and that figure is growing at 18% annually. If we look further, and examine how space-derived technologies contribute to groundling industries such as energy, transportation, communications and materials, we see that some $300 to $500 billion per year enters the GNP from space technologies.

That is the profit that this nation reaps each year from our rather modest investment in space, an investment that has totalled less than $140 billion between 1958 and 1988—less than half a single year's defense budget.

Now that we know what our profits are, we can begin to think about how much we want to plow back into further investment. Successful high-tech corporations typically invest more than 50% of their profits in research. But since our investment comes out of tax dollars, while our profits come from private industry, we must set our sights much lower. Let's use a figure of 10% as the outside limit of our investment in space. That means we have an "envelope" of some $30 to $50 billion per year.

You can argue with those numbers and assumptions. But the *process* of determining the contribution to the GNP from space and using that figure as a key to developing a rational investment policy for future space programs—that is the important feature. That is how we can break out of the Either/Or dilemma.

Furthermore, when it comes to deciding on how to spend the space budget, which programs to invest in, we can use similar logic.

First, we must decide on our goals. I propose that the National Commission on Space got it right in its 1985-86 study: our goal should be to extend human society throughout the inner Solar System. We must stop thinking of one *place* or one chunk of *hardware* as a goal, and begin focusing on expanding the frontier that begins a hundred miles overhead.

The Moon or Mars? Both. A manned space station or a private industrial facility? That's like asking if you want a roof over your head or food in your stomach.

Certainly we will have to decide on the sequence in which we do things. Some can be done simultaneously, such as the space station and the ISF. Others will be done on a stepping-stone se-

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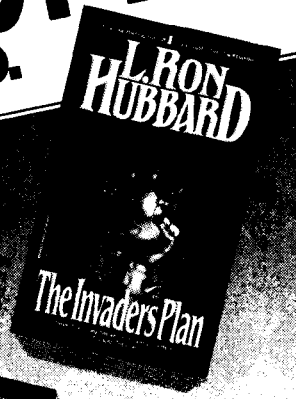

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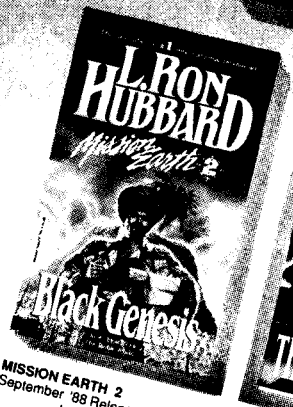

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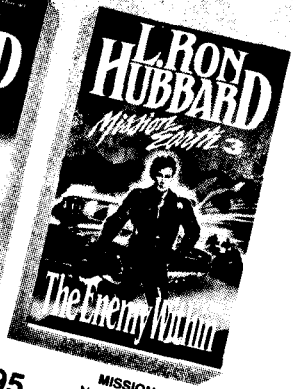

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quence.

At each stage we should ask a pragmatic economic question: How will this development affect the economy? What new economic payback can we expect from this effort?

To paraphrase John Kennedy: Ask not what this will cost. Ask, rather, how much will this pay back to us?

This is the way successful corporations make their profits. This is how Japan became a major industrial power. In fact, it is the way the U.S. became a major industrial power, a century ago!

This approach, this process of looking on space as a necessary area of investment and development, rather than as a luxury, is the way to break out of the cruel tyranny of the Either/Or Fallacy. Until we do, our efforts in space will always be governed by politics, expediency, and myopia. ■

IN TIMES TO COME

● We have another Kelly Freas cover for our August issue, this time for Lois McMaster Bujold's "Labyrinth." It's another of her "Miles" stories, but quite different from the last one you saw here—among other things, despite a serious underlying theme, it has at least one of the funniest scenes of its type I've seen in quite a while. I can't tell you very much more than that without giving too much away (Kelly had the same problem in picking a cover subject!), but I think you'll enjoy finding the rest out for yourself. For now, let's just remark that to make the best of any situation, it's highly advisable to have the clearest possible understanding of everything that pertains to it—including yourself.

Elsewhere in the issue, Rick Cook has a fact article on "Neural Nets," a fundamentally different kind of computer currently the subject of many intriguing experiments. You don't program them—you teach them. And you may not understand exactly how they learn, but the process sometimes bears an uncanny resemblance to the way we carbon folk do it. . . .

And, of course, we'll have a variety of other fiction, including a new "Soulminder" novelette by Timothy Zahn and stories by Charles Sheffield, Mary Caraker, and Geoffrey A. Landis.

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—Science Fiction Chronicle

"Foster has a knack for creating amusing and occasionally chilling alternate realities." *—Locus*

A WORD FROM Brian Thomsen

***Vacations are fun, a time for new experiences or the opportunity to reacquaint yourself with someone or something. I always like to travel to different parts of the country, meet new people and make new friends, whether it's for a weekend convention or just a bit of sightseeing. (I have to admit, though, that I've never taken the Hell turnoff outside of Las Vegas, as featured in Alan Dean Foster's* TO THE VANISHING POINT.)**

East Coast, West Coast, Mid-America, countryside and cityscape: seeing them is what vacations are for. If perchance you can't travel in person, there's always a book to transport you there—from Mr. Foster's hellacious California to* THE HORMONE JUNGLE*'s cities of the future.

When you see me around (at work or on vacation), ask me for some tips on good summer reading.

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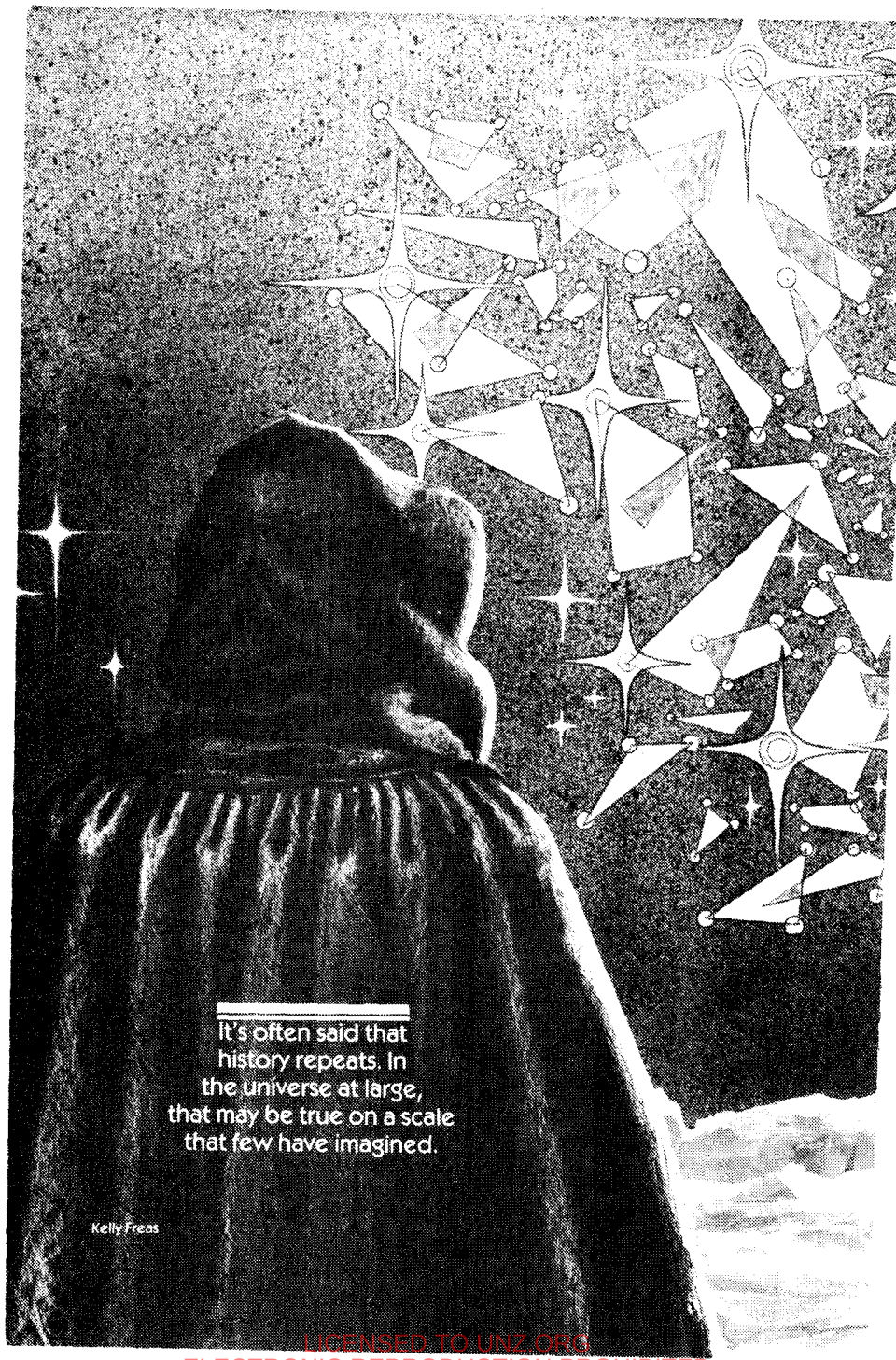
It's often said that history repeats. In the universe at large, that may be true on a scale that few have imagined.
Kelly Freas

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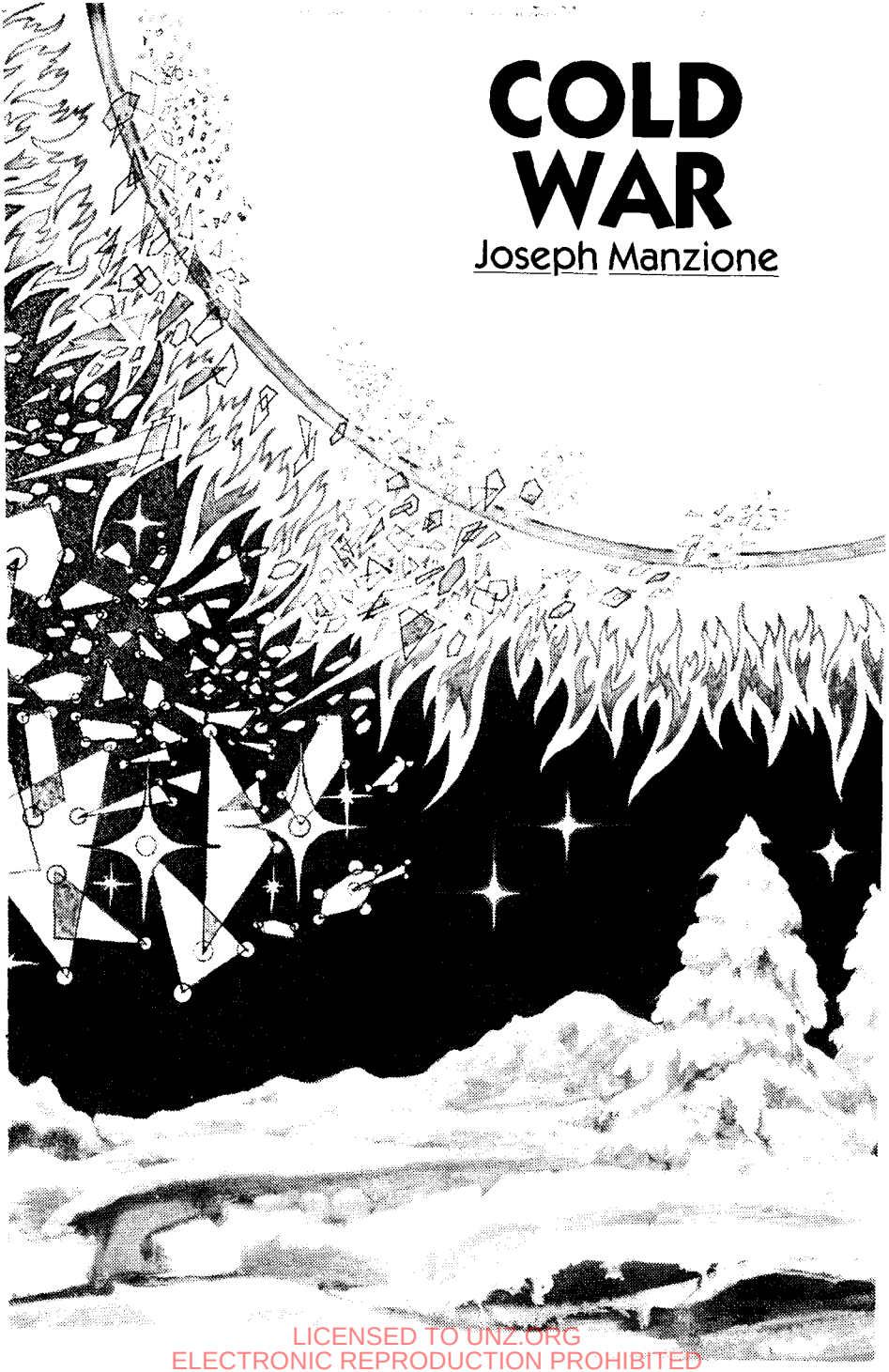
COLD WAR

Joseph Manzione



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"Tell us what happened, priest!" The village idiot stood up from his table at the back of the tavern, a filthy, wooden mug clasped in his gnarled fingers. "Andrei Nikolayevich, what did the bright lights in the sky and the explosions have to do with you, eh? A sign from God, perhaps? A better harvest in the fall? Or was it a sign of disaster? A Christian priest comes to live among Jews in a poor frontier village, and soon the Czar's soldiers will come to collect taxes and enforce Christian laws, and drive the Jews off their farms again. No?"

"Andrei Nikolayevich?" A farmer, a rotund man with a tattered prayer apron tied around his lumpy girth, gestured with his hands. "None of us are educated men, and we don't know what to think. Do you know what the lights in the sky were? The loud noises and blue flashes on the horizon? The hot winds?"

The priest bit his lip unhappily. It was difficult enough to leave Kiev and come East, to bring the Church into the Siberian wastes. It was difficult enough to learn that the majority of settlers in this district were unrepentant Tungus trappers, or Jews. Now, in his second day here, was he expected to explain celestial phenomena to a group of men whose lives were bounded by their fields, their wives' ample arms, and the log shack that served as their synagogue?

"It was a meteor." Seeing the blank looks, the priest tried again: "A stone that fell out of the sky."

The village idiot sniggered loudly and drained his mug. The farmer looked disappointed. "You are making a joke, priest—"

"No, no, Lavka!" the tavernkeeper broke in. "I've heard of these falling stones, in Egypt and Persia. The Talmud describes them as being hot to the touch."

"Yes, they are," the priest said. "They come from other worlds, among the stars in the sky."

"Other worlds!" The farmers stared at him, their bearded, florid faces compressed into bewilderment.

"Beware of Christians telling stories!" the village idiot warned, and stuck out his tongue.

The priest sat back and sighed. What an intolerable place. Even in 1908, the medieval sense of things prevailed.

"The stone came down from space, from beyond our world," he said, wearily. "It grew hot as it fell through the air . . . that is why it glowed. The explosion was the stone hitting the ground. It was far away, so the stone was very big."

He sipped his ale slowly. "And it has nothing to do with me. Believe what you want. I came here to minister to Christian souls in the Tunguska district. Don't Jews welcome tired travelers, whatever their faith?"

The fat tavernkeeper grinned. "Finish your drink, priest, and I'll pour you another."

Several years passed. The Czar's soldiers came and left, but the priest often returned to the village between pastoral rounds. Trappers and lumbermen appeared with queer stories about a place where the forest was flattened and

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burned, in a circle three days' walk across.

The tavernkeeper chuckled. "Remember Andrei Nikolayevich's stone? It was a big stone."

The idyll of village life broke when the idiot abruptly disappeared. The farmers and their families were upset.

"It isn't just that worthless fool," the farmer Lavka told the priest. "One of my cows and two of Lazar's horses are gone."

"I don't know," said the priest. "You say you've seen someone? A stranger?"

"I saw him late last night. He was large, dressed in a cloak with a hood. I didn't see his face. The way he moved . . . it wasn't natural. I think he was a cripple."

"A convict, perhaps. Or a gypsy. Well, we'll find this man and ask him some questions."

Although the priest stayed for a month, the hooded giant did not reappear. Eventually the priest had to go to Karansky, a town a day's ride away, where the Army maintained a garrison. The Jewish farmers were not happy to see him climb onto his horse; since the rabbi died, he was all they had.

"If the hooded man is an evil spirit, then he is merely waiting for you to leave, priest," Lavka said darkly. "You are abandoning us."

"You are a righteous man, Lavka," the priest replied. "If he comes, and he *is* such a spirit, read to him from the Talmud. If that doesn't drive him away, try the New Testament I've given you, and I'll baptize you when I return."

The farmer curled his lip, and ventured a harsh smile. "I've told you what you can do with your bible, priest. Go safely."

The end of the day found the priest riding around the edge of a tangled forest. He was tired, and the patched saddle rubbed his thighs raw. The mare's hooves made sucking sounds in the mud.

The priest started, and looked anxiously along the wagon path. A large, dark figure stood in the golden, slanting sunlight, beneath the broad boughs of a pine tree. It waited as the priest reined in the horse and bent over, trying to discern a face beneath the black hood.

"Do you have a name?" he finally asked.

The figure gave no answer.

The priest climbed down and stood before it, instinctively fingering the heavy cross beneath his robes.

"I suppose if you want to rob me, it's best to do it in a friendly way," he said. "Or are you going to Karansky?"

The black hood tilted slightly. "Are you going to Karansky?" the figure repeated, in a deep, uneven voice.

"A half-wit," the priest said to himself, grimacing. The man had probably been wandering around for months, sleeping in the forest and eating God knows what . . . the good farmer Lavka's cow, the village idiot . . .

He scowled and set his shoulders. "I'm going to Karansky, and I think you'd better come with me. Here, let me see your face."

He reached up quickly and snatched at the hood.

"Let me see your face!" the figure intoned, and its voice pealed like church bells.

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The priest fell back on the ground, clutching in his robe for his cross.

"Jesus, Lord . . ." he gasped, holding the cross up before him. "Protect me from devils who rise out of the black void . . ."

"Protect me!" the creature roared. The intense, almost iridescent blue eyes seemed to stare through the priest's soul. The dark, vermilion skin tightened as the terrified man watched, and the black lips thinned and curled back from double rows of pointed teeth. A dry exhalation issued from a pair of small vents just below the eyes.

"Priest," the creature rumbled, and withdrawing a large, double-jointed hand from beneath its cape, it made the orthodox sign of the cross over its massive chest.

"No . . ." the priest gasped. He closed his eyes, feeling faint.

Something stung his cheek, and he slapped at it. Opening his eyes, he saw the creature shove an oblong device into its cape. His fingers were bloody; the device had taken a patch of skin.

"What do you want?" he whispered.

The creature stood over the priest for a moment, inclining its dark head. The eyes did not blink. "Priest," it said, and hissed softly. Then it turned, slogging though the mud, and disappeared into the woods.

The priest stood up slowly and staggered to his horse. Sweat dripped from his face.

The farmer, Lavka, hammered on the wooden door.

"You see?" the tavernkeeper said. "He's been in there for days, and he won't answer the door. I hear him downstairs sometimes, praying and weeping."

"Perhaps he is possessed," the farmer said, rubbing his fist.

The tavernkeeper shrugged, and said: "Break the door down, Lavka. If he dies in there, the soldiers will come, and God only knows what they will do to me."

The farmer kicked the door in.

The priest sat on the small bed, his body slumped over like a loose sack of grain. His face was moist and puffy.

The farmer turned to the tavernkeeper. "Go tend to your customers."

The farmer sat down beside the priest and put his arm around the shivering man's shoulders. "Andrei Nikolayevich . . . tell me what it is."

The priest choked, and relaxed slightly. "I . . . I saw the hooded one. . . . on the road that evening . . ."

"Ah," the farmer nodded, as if that explained everything.

The priest struggled with himself and then spoke: "I consider myself an enlightened man. I read books . . . natural history, mathematics . . ."

He grasped the farmer's rough hands. "I do not believe in demons, Lavka, I do not believe in demons!"

He subsided and withdrew. "Not the kind that physically ascend from hell to torment the innocent."

"This man is a demon?"

The priest nodded miserably, rubbing the scar on his cheek.

"Well?" asked the tavernkeeper, when Lavka returned to the common room. "How is he?"

"Asleep," the farmer replied, shaking his head. "I don't know. . . . I think he has gone mad."

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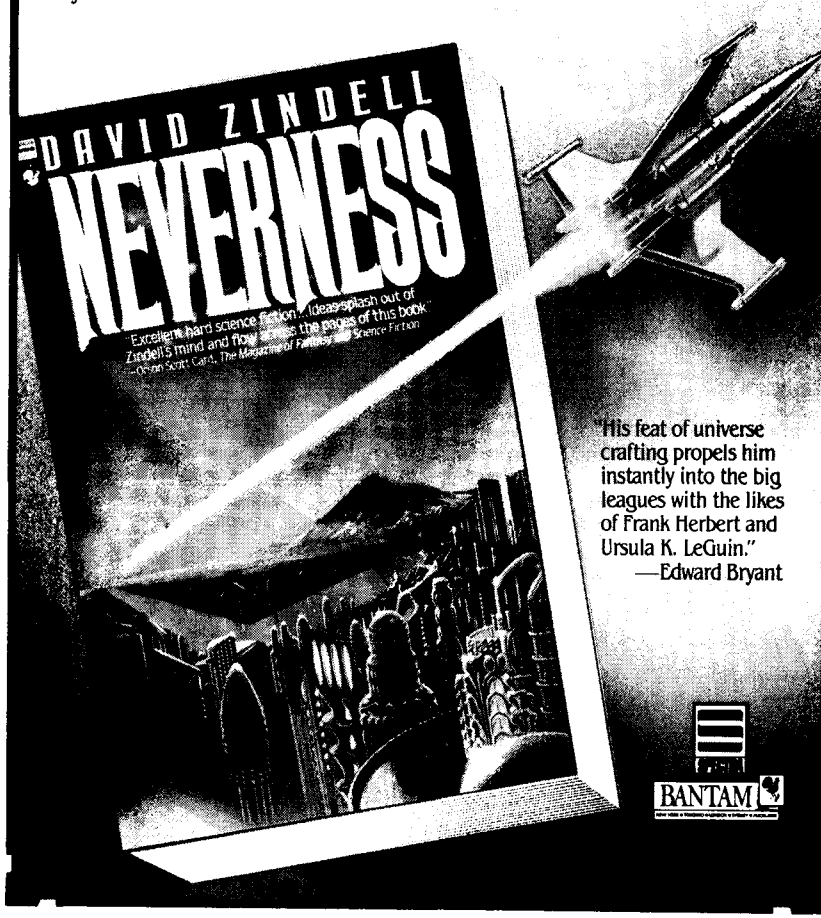
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BANTAM

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The tavernkeeper, the farmer, and several others stayed late that night, drinking ale and talking about the priest. Eventually, drunken and morose, they fell asleep at their tables.

The priest lay in bed and tried not to dream. When he felt a hand on his shoulder, he immediately wakened. In the dim light of the oil lamp, the creature stared down at him with unfathomable blue eyes.

"Is it time?" the priest asked tonelessly.

Lavka heard them coming down the stairs and sat up, blearily rubbing his eyes. The tavernkeeper raised his head and gasped.

"Do you see?" The priest motioned to the huge, hooded figure that cradled him in its massive arms. "It has come back to take me to its master. I am a sinner! I've had too much pride, I've believed too deeply in the faith of men. I am a sinner, and now I go to my reward!"

The creature roared: "Sinner! Reward!" and sweeping around the horrified villagers, elbowed the tavern door open and vanished into the night.

The Sun beat down on the fallow field where the farmer Lavka labored. The hard clay was tough on the old horse and plow, and Lavka cursed the blisters on his hands.

A shadow fell across his cupped palms, and he turned. A hooded figure, silhouetted in the sun, sat on horseback before him.

"God!" he screamed, falling over his plow. "Please!"

"Excuse me," the figure said, climbing down from the horse and pulling back its hood. "Did I frighten you?"

The farmer stared. "You!"

"Yes," said the priest. "I wonder, can you tell me which way to Karansky? I must find a train."

The farmer shook his head. "Andrei Nikolayevich, it is Lavka! What has happened to you?"

"I'm sorry," the priest replied. "You've mistaken me for someone else. Where is Karansky?"

Lavka noticed that he was wearing roughly tailored canvas pants and a leather shirt. There was no cross at his neck.

"Down that road," the farmer pointed. "A day's ride."

"Thank you." The priest smiled awkwardly. "I am traveling across Russia, you see. To Europe. Maybe to America. The train is the best way, yes?"

The farmer sat in the Sun for a long time after the priest rode away.

APOCALYPSE

The shells from the German artillery at Gumrak station were coming closer now, arcing over the slopes of the Mamayev Kurgan and down into the Krasny Oktyabr factory. The concrete buildings disappeared in a cloud of dust and flames, and Colonel S.Y. Gorishny cursed and ground his teeth. Such fire control! If the Germans maintained it, their infantry would encounter little resistance from the deafened Soviet survivors in the basements and sewage tunnels beneath that sector.

Gorishny pounded on the C.O.'s broad back, trying to get his attention through the din of explosions, jangling

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telephones, and men shouting on the river embankment beyond the iron barge. Chuykov finally turned from the map he had been studying and stared at the colonel.

"General, look at that! My command is not going to remain an effective fighting force under such bombardment!"

Chuykov shrugged. "Yes, yes. You have a point. What do you want me to do about it?"

Gorishny opened his mouth and closed it. "I don't know."

"Well . . . it *is* serious." The general frowned. "If we don't plug the breakthrough at Barrikady factory, the Nazi slugs will push us back across the Volga. Goddammit! That'll be the end of the Stalingrad salient, and Yeremenko will shoot my ass. No, we will have to help you somehow."

Chuykov chewed his lip and smiled. "Ah! Lyudnikov and the 138th Division will be crossing the river tonight. I'll give you several regiments, but don't send the men down into the tunnels yet. No, when the Germans move south from Barrikady tomorrow, you'll lead the 138th into your sector in a counterassault, yes? You'll hit the bastards hard."

That night, Gorishny stood on the battered landing stage extending out onto the turgid Volga, watching the division disembark from wooden barges. In the stark brilliance of the flare-clusters hanging in the smoke-scarred sky, the shadows of soldiers struggling up the muddy embankment twisted crazily across the water.

"They're either too young or too old," he remarked to Lyudnikov.

"They're *always* too young or too old," the division commander replied. "These were pulled out of the remnants of the Ukrainian Home Guard, after the Kharkov campaign. They've been back on the line less than a week."

"Well, shit!" Gorishny rubbed the stubble on his chin. "I'm supposed to send them up against the 16th Panzer Division tomorrow morning."

Lyudnikov shook his head. "I know. Here . . . let me introduce you to someone."

He motioned to a small soldier in an ill-fitting greatcoat. "Here's one of my best. Corporal Andrei Nikolayevich Viskov."

Gorishny stared. "What? He's a boy! Not fourteen years old, I would guess!"

"He says he's nineteen," Lyudnikov said, returning the boy's salute. "But I think he's twelve. No matter. He wiped out a German scouting column with grenades, so I made him a corporal."

"Hello, son," Gorishny said. "Are you prepared to get your ass shot off?"

"I will shoot German asses," the boy said simply.

West of the river, behind the miles of skeletal ruins, the night lit up with a barrage of orange flashes. A wailing sound trailed through the sky, followed by another, and then several more. A sheet of water geysered from the river, and the landing stage shook beneath their feet.

"German 88s," Gorishny remarked, throwing down his wet cigarette in disgust. "We'll get no sleep tonight!"

The German patrol commander, a Panzer captain named Hasselhof, licked his lips and considered the collapsed wall. He did not like it down here, in

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the sewage tunnels below the tractor factory. Every dim junction and muddy, brick-lined shaft promised to be filled with screaming, filthy Slavs. The idea had been to send a picked unit down underneath the Russian barricades, to scout a way to pass a couple of battalions into the factory housing development for a rear assault. A squad of Russians had discovered the Germans a while ago. Now they lay dead in a ventilation shaft, but the captain's two sergeants, veterans of three years of war, swore the unit was being followed.

The captain was anxious about the possibility of getting trapped. The tunnel he had led his troops into ended in a large valve-room. The wall and outlet shaft on the far side had collapsed; water flowed through, but the fall of masonry and stone blocked further progress.

"What about it?" he asked his engineer.

The man spat. "We're under the housing development right now, I'd guess. That shaft would be the way out."

"Can we dig through it? Or could we blast through?"

"Captain!" one of the sergeants walked over. "I've put a few men down the catwalk to secure our rear. The others should rest."

"Yes, but only for ten minutes. You! Engineer! Make your assessment quickly. I want to move on."

The captain sat down and closed his eyes, drink on his mind.

"Shit!" He was on his feet in a second. Firing had erupted far down the access, and Kessler was already moving out with a handful of soldiers. Hasselhof shouted to the other sergeant: "Stern! Put the rest of the men around the entrance, and be ready to move on my order! Go!"

The silence stretched through many minutes. The captain walked a hundred yards into the access, and fidgeted. Fierce firing erupted again in the distance. Several explosions loosened pebbles and masonry from the arch above his head.

Three terrified soldiers ran up the catwalk, the sergeant at their rear.

"Kessler! Where are the others?"

"Dead!" the sergeant panted, pulling Hasselhof into the valve-room. "The rear guard was wiped out, too. I didn't even see the bastards who attacked us."

"You can't tell me how many there are?"

"Captain, there's something else." Kessler was shaking. "Those men, they weren't shot. They were burned down."

"What!"

"I mean they were burned—no faces, no skin."

Hasselhof scowled. "Get a hold of yourself, Sergeant!"

An explosion ripped through the entrance to the valve-room. The soldiers by the concrete and steel portal went down on their bellies, laying down an erratic pattern of fire.

"What are we shooting at?" one of them shouted.

"I saw something!" someone else screamed.

The captain shook his head. Things were out of control. "We're going to have to break out of here. Kessler, form a shock squad, and—"

"No," the sergeant interrupted. "You didn't see the bodies."

"Shut up!" the captain ordered.

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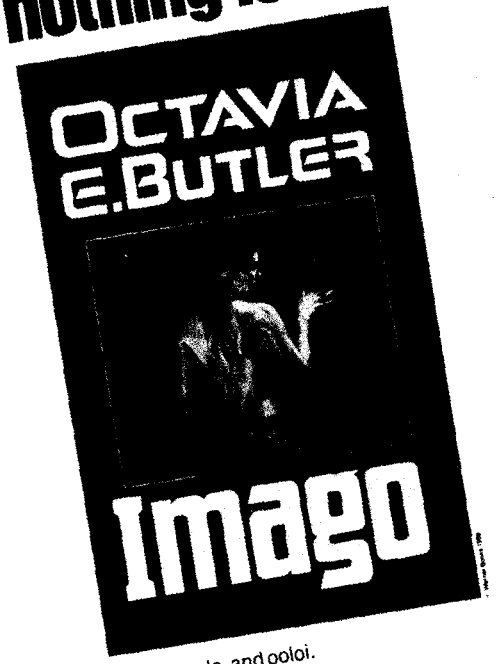
In a world with three genders, nothing is simple.



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Another explosion lit up the portal, and several soldiers squirmed on the wet floor, clutching themselves.

"I won't do it!" Kessler shouted. There was a bright flash, and he flopped across a brass valve-casing, the right side of his neck and torso crisped to the bone.

Hasselhof crawled towards the portal and gazed out. He saw nothing but the catwalk running down the access, and below it, water gushing around fallen blocks of cement.

Beneath the catwalk, a face suddenly appeared. It looked thin and unformed, like that of a child. It smiled at him, exposing a perfect row of small, shiny teeth.

Another explosion rocked the entrance, and the portal bracings gave way. Dust and rock fell into the valve-room, a thick curtain lit hellishly from behind by a rapid barrage of blue and violet flashes. Hasselhof buried his head in his arms, hearing the screams and hysterical curses erupting around him, and smelling unimaginable odors—disintegrating flesh, burning concrete, boiling blood and sewage. A whirling funnel of fire ignited in mid-air, and the great brass valves abruptly softened and sprayed liquid metal through the room. The iron floor under his body bucked and heaved like roiling mud.

The tumult died down. Water dripped somewhere in the ruined chamber.

Hasselof raised his head. Sunlight streamed through the shattered ceiling. A figure stood over him, silhouetted in the swirling dust. Hasselhof squinted. It was a boy, dressed in a woolen great-coat, such as the Ukrainian soldiers sometimes wore. In his arms he cradled a black weapon with large, soft grips, and several tapered barrels.

"Well, Captain," the boy said, in flawless German. "My commanding officer, Colonel Lyudnikov, will want to talk to you."

"I will tell him nothing," Hasselhof insisted hoarsely.

"You will be very cooperative," the boy said, smiling.

"I will tell him everything," the captain replied, suddenly feeling confused. He watched the boy slip the unfamiliar weapon under his coat.

"Get up," the boy said. "I'll show you the way."

Smoke curled up from the ruins of Stalingrad, staining the afternoon sky a torpid brown. Somewhere along the street there was a shout. Gorishny turned and saw several Russian soldiers, rifles leveled, escorting a ragged group of German prisoners.

"Colonel! Over here!" the lieutenant called. "Here is another one, in the same condition."

A German tank straddled a flattened brick wall, its steel structure burned and blistered. Where it had been hit, just below the armored skirt, only twisted fragments remained. The lieutenant scrambled up onto the turret.

"Do you see, Colonel? The steel crumbles, like stale bread. From the impact point back to here, I can break it apart with my hands. Like the other tanks. What could do this?"

Gorishny shrugged. Not a grenade or a rocket. Not a shell.

He watched the lieutenant gleefully rip apart the tank turret with his bare hands. Metallic powder glinted in the

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troubled air around the man. First, the hysterical Panzer captain's story, and the burned bodies beneath the tractor factory. Then reports of German regiments collapsing for no apparent reason. Now this. Gorishny shrugged. *You can't explain it. It's just war.*

ABIOGENESIS

The mountain was a desolate spine of granite at the summit; nothing grew above the last line of gnarled pine. In the slanting sunlight, the arid basin below seemed to have a quality of life itself. The mottled pattern of scrub trees and grass, the dry washes wrinkling the earth, the shattered rock and smooth expanses of sand gave the land the texture of aged skin.

The youth stood on the ridge and stared down into the basin, his arms rigid and his fists clenched. The land lay still, like the body of a man before the final shiver of death, or a woman, blooded and tense, preparing to give the final shove of birth.

There was the slightest quiver, somewhere in the distance . . .

Light erupted, leaping from horizon to horizon, overwhelming the world in a torrent of incandescence, melting rock and air and living matter in blind violence, spilling outward like the wave front of some cataclysmic event that might thunder up and down the scales of human memory, so that all who heard, wherever or whenever, would pause, and look up. . . .

Viskov laughed, his open mouth a faint shadow in the firestorm, until the blast and sound arrived and knocked him down the mountainside. His shirt and pants tore away, his shoes shot off his feet, his mouth was stuffed with warm, fused sand. He fetched up against a stone, bleeding and bruised, and rolled over on his back. Above, an enormous cloud rose into the blackened sky, darkening rapidly from orange to dull, brick-red. Rain fell, leaving yellow splotches of mud on his exposed skin.

He rubbed his head and sat up. The searing heat felt good. It brought back memories alien to his senses.

"Comrade, what happened to you?" the truck driver asked, when Viskov flagged him down hours later.

Viskov stared at the empty road, fingering the burned skin around his eyes. "The light. I can use it. I can make it work."

"Light? Ah, you mean the big explosion in the restricted area back there, do you? I saw it, too. Someone at the depot said that the Americans had dropped one of their atom bombs there. But I told him he was full of shit. They know what they're doing, our scientists. I told him *we* had the bomb now, and everything would be all right with the Americans. 'Wait and see, comrade,' I said."

THE NEW WORLD

The Plowman died on a spring evening in 1953. The day had been grey and cold, with flurries of dirty snow, but the setting sun spilled colors like warm blood across the bland concrete surfaces of Moscow. A single bell tolled within the towers and walls of the Kremlin.

Viskov was sitting before the fireplace in his apartment when the telephone jangled.

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"Stalin is dead," Khrushchev said simply. "Come to my office."

Kaganovich was waiting in the marble foyer, and showed him through the doors. Inside, Khrushchev sat with his feet propped up on the desk. The soles of his shoes were worn through. Malenkov sat in a leather chair in a corner, scowling unhappily.

"Andrei Nikolayevich!" Khrushchev said heartily, his feet coming down to the floor with a bang. He rose and stuck his hand out. "Welcome, welcome. Comrade Malenkov, this is the young man I told you about. We met at Stalingrad, where I was a political commissar and he was a little boy with corporal's stripes!"

He smiled and winked. "Since then, he has done me several favors, yes? He can help us."

Malenkov stood up and stared at Viskov. "How exactly do you serve the Soviet people?"

"I am an assistant administrative director for the Academy of Sciences, Comrade Malenkov."

"I see. You are a little young, aren't you?"

"*It is a job I do well, Comrade.*"

Khrushchev cleared his throat. "Andrei Nikolayevich. The next few months will be difficult, and many of the things we have to do—" he indicated himself, Malenkov, and Kaganovich with a sweep of his hand—"are of a delicate and unpleasant nature. A situation has arisen that must be dealt with immediately, and because of its sensitivity, certain state security organizations must not be involved."

"You wish me to do something about Comrade Stalin's personal secretary, Poskrebyshev."

"Remarkable," Kaganovich observed. "How did you know?"

"Poskrebyshev is also head of the Special Section of the Secretariat," Viskov replied. "He is head of state security."

"He was also preparing to eliminate us, with Stalin's blessing!" Malenkov said sharply.

"You understand our problem, Andrei Nikolayevich," Khrushchev remarked quietly. "The three of us might wield enough power in the Politburo to ensure an orderly transition. We do not need to be threatened by this Poskrebyshev. Make him disappear, as though he were taken off the face of the planet."

"I understand."

"Can we count on him?" Kaganovich asked, when Viskov had been shown out.

"Yes," Khrushchev answered. "I've never had a better operative. Most of them are stupid, you know. But not him."

Viskov stood in the deep snow at the edge of the field, with his hand on the other man's shoulder. Poskrebyshev lurched forward to his knees and was sick again.

"I can give you anything you want," he said thickly, wiping his mouth on the torn sleeve of his shirt.

"You have nothing I need," Viskov replied mildly.

"Are you going to shoot me?"

"No. We are going for a ride. Look up."

As Poskrebyshev stared at the grid of

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violet lights descending out of the night sky, Viskov said quietly: "In a way, it is an exciting thing for you. You will be the first human being to take a walk in space."

A MINUTE BEFORE MIDNIGHT

It was a rough day for Mike Halprin. National Airport in Washington, D.C. was always hectic, with international flights arriving and departing at all hours. Halprin and his crew of U.S. customs agents often acted as spear-carriers for the Department of State, the FBI, and the CIA. Today it was very bad. Kennedy had accused the Russians of placing ballistic missile launchers in Cuba, and everyone expected a shooting war to erupt momentarily.

Lunchtime came, and Halprin listened to the Russians denounce American "war-mongering hysteria" over the radio. An hour later, families of foreign diplomats began straggling in from various embassies, bartering for quick flights to London, Mexico City or Tokyo. Anxiety in the airport was palpable, and Halprin found himself calling his wife every hour, just to hear her voice.

The phone rang. "Mike? It's Floyd, down at the Lufthansa gate. We got ourselves a situation. You better come down."

Halprin grunted wearily and hung up.

A man waited with his agent, just inside the gate. He was well-tailored, in a dark suit and red tie, with thick, dark hair cut rather stylishly. A West German, by his look.

"Mike, this is Andrei Nikolayevich Viskov, from the Soviet Union," the agent said, with a meaningful look.

Oh, good Christ! Halprin thought. He stuck out his hand. "Really? Good to meet you, Mr. Viskov."

"A pleasure, sir," Viskov replied in flawless English.

"Mr. Viskov is not on the official arrival list today," the agent said mildly. "However, his passport is in order."

"I see. Mr. Viskov, as a courtesy, the United States and the Soviet Union give each other travel lists, so that customs officers can prepare for official visits. May I ask who you are and what your business in the United States is?"

"Of course," the Russian replied. "I am chairman of the State Committee for Science and Technology, a member of the Central Committee of the Soviet Union, and a political advisor to Secretary Khrushchev. It is my purpose to visit the Soviet embassy here and consult with its staff."

Halprin glanced at Viskov's passport again. "Excuse us for a minute, please."

Pulling the agent a few yards down the hall, he whispered: "Can you believe this? Look, take him to my office. I'll call the State Department and find out what the hell we're supposed to do."

A limousine and an escort arrived for Viskov within an hour.

"We are speaking off the record now, Comrade Viskov. Yes?" Dobrynin asked.

Viskov nodded.

"Then I can tell you what a stupid thing it was to do!" The Soviet ambassador thumped the table beside his chair. "Kennedy will not accept the missiles in Cuba. We should have been consulted. We'd have made it clear how the

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Americans would feel, especially during a congressional election year."

"Kennedy will order a military strike against Cuba. That is what you are saying?"

"Yes, yes! And Khrushchev will be forced to retaliate, and then where will we be? On the losing end of a nuclear war!"

"Let us imagine that the Americans do not take military action against the missile sites," Viskov suggested. "Perhaps they will take a less threatening course, like a selective blockade."

"Selective blockade?" The ambassador straightened. "Use the American navy to enforce a quarantine of Cuba? You know of this?"

"Possibly. A blockade will present both sides with more opportunities to negotiate, do you agree? Good. Now, Comrade Dobrynin . . . if Kennedy declares a blockade, will you transmit your opinion to Khrushchev? Your message would have great impact."

Robert Kennedy arrived home very late. The children were asleep, sprawled at odd angles across their beds; Kennedy tucked them under their covers and walked into the kitchen. The second hand of the clock above the oven caught his attention. It marched around the dial with ruthless precision, winding through a long countdown to midnight. Every tick was like a knife in his ribs.

He went into the bedroom, unknotting his tie and unbuttoning his shirt, and tossing them on the floor. He lay down beside his sleeping wife, and stared at the ceiling. Shadows wavered across the smooth paint, hands, shriveling claws, skeletal, coming apart in the hot winds of the blast. . . . Kennedy blinked. The ceiling was a blank space; there were no shadows.

He sighed, and got up and went into the bathroom. Turning on the light, he filled the basin and splashed water on his face.

A man sat on the toilet lid, looking at him.

"My God!" Kennedy said, leaping back against the sink. He snatched up a large wooden hairbrush and held it out in his fist.

"That won't be necessary, Mr. Kennedy," the man said, standing up and straightening his jacket. "I'm here to talk to you, not to hurt you."

"Who are you? How did you get in?"

"A breach in your security. No one is to blame. My name is Viskov, and—"

"I was briefed about your visit. Mr. Viskov, for a man who professes benign intentions, you've—"

"Yes, yes, Mr. Kennedy, I have behaved irregularly. These are irregular times, don't you think? I assure you, I mean no harm. I must speak with you privately before I leave tomorrow. Please."

Kennedy considered for a moment, and put the hairbrush down. "They tell me you're an associate of Premier Khrushchev's."

"I am."

"Khrushchev and his associates have unorthodox ways of doing business. What do you want?"

"Mr. Kennedy, your brother listens to you. I would have gone to him, but White House security is inconvenient and I need secrecy, above all. No one must find out that I have consulted directly with the attorney general of the

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United States, or the consequences will be serious."

Viskov paused and shrugged. "I will be blunt. You must not take military action against the missile sites in Cuba. If you do, Mr. Khrushchev will be forced to retaliate. He will have no choice; there are others in the party and the military who have a say in such matters."

Kennedy dipped his hand in the sink and splashed the water around. "The sites must be dismantled. It was stupid to put them there in the first place."

"I understand, sir. Comrade Khrushchev must walk a fine line between many interests. And to be truthful with you, he is a passionate man who does not possess the subtle qualities necessary for a great leader. Are there other measures of a less threatening nature your government might consider?"

Kennedy held a wet hand up. "All right, Mr. Viskov. One of our people suggested a naval blockade as a more moderate policy of retaliation. I'm considering the idea. It may give us additional options, and force your government to consider the consequences of escalation. What do *you* think?"

Viskov smiled broadly. "It is an excellent response."

"Perhaps. What will you say to Mr. Khrushchev in Moscow?"

"I'll tell him that the Americans mean to have the missiles out of Cuba, and if he insists on keeping them there, he'll have to fight a war. The Ministry of Foreign Affairs and the embassy here will support my argument. I'll suggest that he open a private dialogue with your brother, with the intent of dismantling the sites without loss of face."

"Will he listen to you?"

"Yes. But he will not decide until the blockade is in effect, and he has to. I know him."

"I see." Kennedy looked at the man. His face was healthy and unlined. His suit was impeccable. His English even had the faint trace of a Boston accent.

"Khrushchev doesn't know you're here, does he?"

The Russian waited silently.

"It'll be our secret," Kennedy finally said. "You're an extraordinarily resourceful man, Mr. Viskov. I hope you will not have further occasion to break into my house."

WAR OF THE WORLDS

The Myasichev Mya-4 bomber broke through the fog and dropped, bouncing along the runway. The worn jet turbines howled painfully as the old plane slowed down, trailing chunks of tire-tread along the blackened concrete surface.

"Shit!" the engineer Tokady muttered to his associates, as they watched the aircraft bob to a stop. "He's not going to be in a good mood after that landing. Are we in such trouble that a junior member of the Politburo has to fly in that junk?"

"It was the pilot's fault," remarked the administrator, Medvedev, smiling ruefully. "He is obviously not a practicing communist."

Everyone laughed.

"So the pilot gets transferred to Kamchatka, and we end up cleaning toilets at the academy in Smolensk," Tokady said bitterly, "all because a shithead in Moscow decides he's against the Mars mission agenda. *That* is Soviet justice!"

"Don't be so anxious, Karl!" the

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third man, Joravsky, cautioned. "I know this one. He is not an animal, like most of these Moscow *apparatchiks*. He will not relieve you of your head."

"What a comfort!"

The truck bearing the visitor pulled up to the small wooden terminal. The man who climbed down was of medium build, with dark, graying hair cut longer than was common. He stared straight ahead as he trudged through the drizzle towards the gate.

"How can a person be a Russian and have a scientific background, and be against Mars?" Tokady asked rhetorically. "I tell you, it is not a proper communist attitude!"

"Only Tokady has a proper communist attitude," said Medvedev, smiling again. He glanced through the gate. "Quiet! Here he is."

The visitor glanced at the three men quickly, and said: "You are Medvedev. You are Joravsky. I've read your paper on the solid fuel debacle. You are Karl Tokady."

"Comrade Viskov, welcome to Pavlodar Cosmodrome—" Medvedev began, but the man waved a hand and cut him off.

"Come, you are not happy to see me. I know that. You think I am a meddling shithead, who unfortunately has the power to break you and send you to Smolensk, to clean toilets at your academy."

He stared meaningfully at Tokady, whose mouth had dropped open. "I have that power. Whether I'm fool enough to use it . . . we shall see, Comrades!"

The drive to the cosmodrome was made in silence. Viskov stared out through the car window at the dark forests.

"Comrade Viskov," Medvedev finally said, "I think you are being unfair. After the Americans landed on the Moon last year, the bureau commissioned a study of prospects for manned exploration into next century. Mars is logically the next step. The Americans will go there, whatever we do."

"I have read that report," Viskov replied. "It does not answer a basic question. What will you do when you get there?"

"Why . . . ah . . ." Medvedev looked helplessly at his associates. "What do you mean?"

"Comrade Medvedev, the meaning of the question is perfectly clear. I am asking you, what is the agenda when you finally reach Mars, ten years from now? What will you do? The Americans picked up rocks on the Moon. What will you do to justify spending billions of rubles and years in the lives of capable Soviet scientists and technicians?"

"I don't understand it!" Tokady interjected angrily. "You are a scientist. How can you think this way?"

"Karl, please—" Medvedev said, but Viskov shook his head.

"I am also a politician," he said. "I am responsible for the progress of Soviet science and technology. I am an advocate, but I am also a tool of socialist discipline. I ask you again, what will you do for the Soviet people when you get to Mars?"

"Prestige—" began Medvedev.

"A fleeting and ultimately valueless commodity," Viskov said harshly.

"Technological benefits deriving from our efforts—" Joravsky ventured.

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"There are less expensive ways of deriving the same benefits," Viskov interrupted.

Medvedev tried again: "Exploration, the ethic of science—"

"—does not put food in the mouths of the people," Viskov cut him off. "It does not give them the hope that their children's lives will be more meaningful than their own. You will have to do better than that, Comrade!"

"For God's sake, what do you want!" Tokady exploded.

"Karl, restrain yourself!" Medvedev snapped. "Comrade, forgive him. He is under strain, supervising the launch."

Viskov merely nodded, and turned away to look through the window again.

After a minute, he said: "Engineer Tokady, I will tell you what I want. I want space. I want to give the Soviet people the option of living in it and using it. I want it to be our legacy to generations to come, who may need such options more than we do. It means nothing that the Americans sent a few people to the Moon. We will construct an orbital platform, and live on it. The Americans can go to Mars. We will build bases on the Moon. They can send a mission to Jupiter, or Saturn. We will colonize Mars. They can design a ship to transit around Alpha Centauri. We will build our homes there."

Viskov smiled as he stared out through the rain-streaked window. "They have expertise and technology. They are more innovative than we are, perhaps. But we have *determination*. We will be slower, less impressive. We will lose more people, and suffer more adversity. But in the end, we will be spacefarers, and they . . ."

He raised a hand. "Good. There is the main gate. You must let me inspect this big rocket you have built, Comrade Tokady."

Tokady took his hands from his face and looked up. Joravsky lay next to him. The man's skull was split open, the brain tissue like a moist, red rose unfolding. The roof and the impact wall of the launch operations bunker had been sheared away. Rain cascaded through the gaping holes, hissing on the smoldering rubble and overturned equipment.

Tokady sat up and rubbed the grit from his eyes. Viskov stood over him.

"The rocket . . ." he whispered.

"It blew up."

Tokady blinked and focused his eyes. The Politburo member's greatcoat was ablaze around the arms and shoulders. Water fell on the man's hair and face, spattering the flames. His body was wreathed in fire and smoke.

"Listen to me," Viskov said. "The induction turbines created too much heat and flux in the fuel-feed assembly. The metallurgy wasn't there, Engineer. It is a problem of poor materials."

"I know," Tokady said dully. "I tried baffling the flow tubes and insulating the pumps, but I had no time to test the fix."

The burning figure bent down close. "It's not the way to do it, to let the Americans set your agenda for you. You must be slow and methodical. You must plan and build in increments. Don't look for technological miracles, they don't happen that often."

"I'm sorry," the engineer said brokenly.

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Viskov straightened and pulled the remains of his coat off. "Stand up, Karl. We have to find Medvedev. There is much to do."

DETENTE

Carlucci, the American secretary of defense, leaned over to an aide, and said: "Peter? The man with the red tie, sitting a few places to the left of Gorbachev . . . I don't recognize him."

"Who? Oh, *him*. He's a legend among the Russian-watchers, Frank. That's Viskov."

"*He's* Viskov?"

"That's right . . . Physicist, administrative head of the Soviet scientific establishment, member of the Politburo, and one of Gorbachev's closest advisors. The CIA and their European counterparts are having quite a romance with him. Seems his background is a closed issue. Every time they try to pry him open, the Russian networks dry up."

"What's he doing here?"

"He's had a hand in the INF negotiations. At least, he's been in and out of Geneva since the whole process began again in 1983."

Just then the president entered the conference room for the treaty-signing ceremony. Carlucci was obliged to forget about the man in the red tie who had smiled at him so cordially.

FIRST CONTACT

GOSVOK—National Trends Analysis 1998-2023 TERMINAL FUNCTION
document generation 27 September 2008—Moscow encode 774-9

⟨1⟩ projected alpha decline of national GNP, May 2011-March 2013: national resource units expressed as economic percentages ..... *−47%*
⟨2⟩ projected correlated probability of revolutionary instability in border regions A, B, C, F, and G in 2015 ..... *0.83*
⟨3⟩ projected correlated probability of revolutionary instability in Russian core regions A, C, D, and F in 2015 ..... *0.68*
⟨4⟩ projected correlated probability of a general revolutionary state of affairs [Skorzny Incliometric Definition] *0.79*
⟨5⟩ probable date of revolutionary catalyst derived from a Yeltzin alpha-hex regression function ..... *October, 2017*
⟨6⟩ projected correlated probability of revolutionary success under given parameters *0.69*
⟨7⟩ power-to-resource index, USSR, post-revolution ..... *−67.2*
⟨8⟩ power-to-resource index, Sino-NATO, post-revolution . *+41.3*

"It cannot be that bad," the minister of defense protested. "Andrei Nikolayevich, I don't believe it!"

The general secretary turned from the window overlooking Red Square, and stared at the man. "The document is convincing."

The minister looked resentful. "But to embark upon such a corrective measure—"

"Merely the nexus of a number of interlocking plans."

"No! This is not a plan! It is a wild fantasy!"

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Viskov gestured sharply, thrusting his palms outward. "Spiridon Ivanovich! Our political and economic infrastructure is coming apart. Our security apparatus cannot guarantee stability in the border republics, and our administrative efforts cannot guarantee the economic status quo, as bad as it is, for another five years. A military solution is impossible, and I cannot guarantee the welfare of the Soviet nation against the concessions I would have to make negotiating with the Sino-NATO bandits."

"The proletariat!" the minister snarled. "Those lazy asses! If we squeeze them for the requisite consumer production—"

"Squeeze them any further," Viskov interrupted angrily, "and the revolution will come in two years, instead of nine! We have one desperate option. You dare call it fantasy?"

He turned back to the window. In the square, Western tourists were lining up for the afternoon tour of the Kremlin. Viskov noticed the expensive cameras dangling from their shoulders.

"I have built up our space program at great cost, for just this sort of contingency," he said softly. "It serves us well that the American program is still in such disarray."

Viskov looked around. The great hall was dark, except for the light pooling from a single lamp by his chair. The heavy furniture and the ornate paintings hanging on the high walls were mere suggestions in the shadows. It was eight in the evening, and he hadn't eaten dinner. It was time to go home.

He reached for his files, and then abruptly stood up. Someone else was in the hall.

Viskov leaped into the shadows and listened.

"Who is there, please?" he called.

He sensed breathing, and the soft slap of fabric against skin. Moving rapidly, he circled the dim chamber, reaching into an inner jacket pocket and bringing out a hand-weapon with several tapered barrels. Data flowed freely, now that he was focusing on the target; it was an organism a meter in height . . .

⌒*heartbeat*⟩⟩***high and unsteady***

⌒*limb and torso . . tracking*⟩⟩***low value of coordination***

⌒*UV scan . . infrared scan*⟩⟩***zero value coronal reflection***

⌒*vaporous exhalation . . infrared emission*⟩⟩***extreme metabolic stress***

⌒***target unaware of approach***⟩⟩

Viskov moved silently along the wall, black in the shadows.

⌒⟨⟨*imaging analysis indicates zero probability target armed*⟩⟩

⌒⟨⟨*target vulnerable*⟩⟩

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He hit the overhead light switch, his weapon powered up and centered on the back of the . . .

⌒little girl's head ⟨BREAK⟩

She turned and saw him, her mouth opening in a silent scream.

Viskov centered the weapon between her eyes, his finger on the contact, his body easily balanced. He did not blink.

"I was looking for my parents," the little girl whispered, in English. "I lost them."

"Lost my parents," Viskov said.

The girl stared at him and shivered. She had long blonde curls. Her grey eyes were enormous.

"What's wrong with you?" she asked.

Viskov lowered the weapon. "What is your name?"

"Emily Hibbard," she replied, relaxing a little and wiping her nose with a dirty fist. "I don't live here . . . I live in Boston. That's in America. You know where America is?"

He nodded. "Did I frighten you? I'm sorry. You frightened me, too. What are you doing in the Kremlin, little girl?"

She still looked doubtful. "My parents brought me. I thought it was like Disneyland, but it's not. It's *boring*. I saw a room with statues and water and things, so I went to look. Some people came and I had to hide."

She tugged on his jacket sleeve. "I got lost."

"I guess so. Well . . . are you hungry?" Immediately, he knew he had made a friend.

He held out his hand. "My name is Andy. I run this boring place. Now, would you like to come to my office and have dinner with me, while I send someone out to find your parents?"

"You're different from me, aren't you?" the girl asked, around a mouthful of rice and beef.

"You should expect that," Viskov said, settling comfortably into his chair. "Russians and Americans are different."

"That's not what I mean," she said, stuffing another forkful of rice into her mouth. "You're not the same as me. Or my parents, or the guide that brought us here. She was from Russia, too."

Viskov smiled. "If I am so different, is that a bad thing? You can live with it, yes?"

The girl laughed. "Mom says the same thing when she doesn't want to answer a question. '*Live* with it!' "

"Then I am not so different, am I?"

"Yes you are," she replied seriously. "I'm scared of you, because I don't know what you'll do next. Most times I can guess what my parents are going to do, or my friends, even people I don't know. But you're like an empty space. I can't guess at all."

Her lower lip trembled.

"I know what you mean," Viskov said gently. "I'll make a deal with you. I'll tell you everything that I'm going to do, before I do it. You'll do the same for me. Then we can trust each other, because both of us will know if we have lied."

The girl smiled, then suddenly became apprehensive. "What if you hurt me, before I find out that you've lied?"

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Viskov frowned. "That's the problem, isn't it?"

DEUS EX MACHINA

The director of the Central Intelligence Agency was an hour late for his luncheon appointment.

"Karla, I'm sorry. Something came up in the last LONGWATCH satellite dump. I've been in conference all morning."

"Should I know about it?" the secretary of state asked.

"Hell, yes! Another utility platform was launched from Tulun Cosmodrome nine hours ago, into a low-orbit configuration. It's only a skeletal rigging — presumably they'll send up shuttles and BAK-Proton haulers to build the superstructure—but this one is really big. They could hang a dozen ABM batteries on it."

"What do your Soviet sources say?"

"Another engineering project, of course. A *farm*, for hell's sake! I thought Bukharin told you they would hold off on these things until we could deploy the hardware necessary to verify peaceful intent."

"He did—a year ago. I imagine they got tired of waiting, particularly after the Vandenburg facilities blew up again."

The director put his fork down. "Shit, Karla! They've been pushing us hard for the last eight months."

The secretary sighed and rubbed her forehead. "Last night one of our embassy officers in Moscow was arrested. They said he was buying cocaine. When we retrieved him from Lefortovo Prison, his fingers were broken."

The director nodded grimly. "There's a pattern here. Remember the incident last week—the MiG-34s that flew a penetration pattern over our naval facilities in Bahrain? They came in low over the Persian Gulf at Mach two, transmitting standard nonaggression codes while maintaining missile lock on sixteen ground and sea targets."

The secretary mashed her salad with a spoon.

"There's something else," the director continued. "One of my outfits has generated high correlates on a possible Soviet military probe into northern Iran this month. The new natural gas fields, maybe. Or a security operation designed to put a barrier between Islam and Russian religious groups along the border."

"You're kidding!"

The director shrugged. "Corps-sized redeployment, increased training exercises, mobilization of reserves . . . something's up."

The secretary chewed on her spoon and thought. "You know, Paul . . . it's been thirty years since we've seen this sort of behavior. Why now?"

"There are indications. Silly science from one of the secretariat's planning divisions, really. Something about an impending economic crisis."

"Which one? They *always* have an impending economic crisis."

The director shrugged. "Important people seem to be upset."

Colonel Jesús DeMira Escobar, of Bolivia had been assigned to the United Nations contingent guarding the Iran-Iraq frontier for two years. He had seen some frightening things, but nothing compared to the radar pattern his operator was pointing to now.

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"Mary, mother of Christ . . ." he whispered, crossing himself.

He turned to the operator. "Have you identified them? The Iranians have nothing like that."

"The computer can't verify profiles or vectors," the woman said. She was sweating. "The aircraft are of various stealth designs . . . maybe four hundred inbounds. I think they're Russian."

"How much time?"

"Ninety seconds until the first wave hits the buffer zone. Colonel, fire-control is on line. The ASPART batteries are armed."

"They won't do us any good," DeMira muttered. "Stand by."

"Colonel!" someone else called. "The Iranian and Iraqi sector commanders demand to speak to you!"

DeMira made a decision. "Tell them I'm taking a shit, and I'll call them back."

He looked around at the frightened faces. "We're sitting this one out."

Thirty-two seconds later the entire eastern horizon lit up like a blowtorch, as kilometers of Iranian bunkers were vaporized by lobbed, low-yield thermonuclear ordinance.

As if to punctuate the rising anxiety, thunderstorms rolled through Washington, D.C. all during the week. One night, wind and hail tore along the roofs and empty streets like invading banshees. Toward dawn the rain abated, and a thick mist formed. The news that greeted early risers was grim: A Soviet missile frigate, escorting troop carriers bound for the Gulf coast of Iran, shot down an American reconnaissance helicopter. The Soviets expressed regret, but warned that interference from American forces in Bahrain and Kuwait would be met with "deadly force."

Patrick Johnson shook his head as he rode the subway station escalator up onto the green expanse of the mall. So many bad things happening. He remembered the Cuban Missile Crisis, the Vietnam War, and the Afghanistan Intervention. That kind of trouble was supposed to be over forever.

He trudged along a gravel path beneath the sandstone towers of the old Smithsonian building. He had as good a job as a black man without an education could get in this city. He was a security supervisor at the National Art Gallery, and he had a nineteen-year-old son at Howard University. He didn't want any goddamn white man's war to mess things up, draft his son, kill him in some foreign place.

The outline of a large object abruptly appeared through the swirling mist, and he stopped and stared. It was a low, three-legged thing, with round pods slung underneath and a pair of slitted turrets on top. A dish antennae rose above the assembly.

He stepped closer. Stenciled onto the side was an American flag, and some block lettering. . . .

Johnson shook his head. A satellite from the Air and Space Museum? Why put it out here?

At the sound of an approaching vehicle, he turned. "Cusak!" he said, with satisfaction. The assistant curator at Air and Space had called upon Johnson from time to time for security support. He would know about this.

"Mr. Cusak! Hey, Mr. Cusak!"

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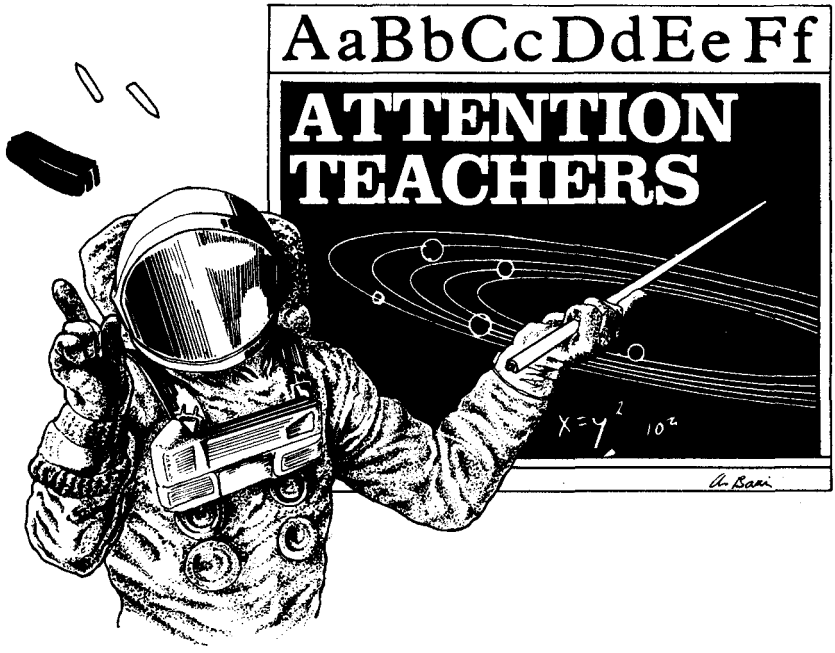

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AFF1

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The red truck slid to a stop, and a door opened. "Patrick?"

"Yeah . . . listen, I wonder why your people put that satellite or whatever it is out there in the grass."

"Satellite? Where?"

"Out there, in the fog. I'll have to show you."

They walked through the mist, and Johnson caught Cusak eyeing him curiously.

"There it is."

Cusak looked, straightened, and stared. He ran over to the object. Muttering to himself, he bent down beside it.

"I don't understand it," he finally said. He raised a cupped palm. Reddish sand fell between his fingers.

"It seems to be *Viking One*. It landed in the Chryse Basin on Mars over thirty years ago."

That didn't make much sense to Patrick Johnson. He glanced down at his feet, and noticed a black metal plaque attached to one of the struts. On it, figures etched an intricate dance:

The militia woman walked the wide paths of Sokolniki Park in Moscow, her collar turned up against the evening snow. She nodded congenially to passersby—couples strolling after supper, laborers hurrying to neighboring taverns, loitering students bartering goods before night classes began.

She followed a deserted track through a stand of trees and into an open field. The snow whispered gently in her ears. She loved the season; the grey dirt and sour sides of the city might be buried for yet another winter, leaving only the purest facade of white and red. Although the grim news from abroad had settled upon her like dust, now she spread her arms and turned around and around, listening to the snow.

She stumbled over something and fell on her face.

Sitting up, she saw a cylindrical object laying in a small drift beside her, its midsection marked by a shallow metallic dish. It was blackened and corroded, and gave off an odor like spoiled eggs and urine.

The militia woman shivered. Whatever it was, it shouldn't be here. It meant paperwork, and the kinds of questions from nameless officials that she hated most. The black metal plaque attached to one of the twisted struts did nothing to allay her sudden anxiety:

The journalists had been ushered out of the great hall, and the *Gosteleradio* technicians were packing up their television equipment and rolling it out through the double doors. Karla Straker looked around and noticed that Bukharin had strong-armed Pauley and Hines into a corner, beneath a wall-high portrait of Peter the Great. The Soviet foreign minister was gesticulating forcefully, while her own two aides glanced at her unhappily.

The American secretary of state plastered a comfortable smile on her face

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and turned back to her host. Only the Russian translator sat with Viskov now.

"I'm sorry. What did you say?" Straker asked the woman.

"The general secretary observes that the press conference was a success," the translator said smoothly. "He believes your unbiased manner will go far towards defusing the present crisis."

Straker curled her lip. "Thank him for me."

The general secretary seemed amused. Turning to the translator, he said: "Mrs. Cheprakova, leave us now. Thank you."

"I assume you want to talk to me privately," Straker said, when the woman had left.

Viskov pointed. "There is a garden through that door. We won't be observed or recorded, I promise you."

The garden was full of roses. White and red flowers trailed off the crumbling stone walls and rose from the grass in neatly trimmed thickets. The flagstone walks were lined with pink.

"A passion of mine," Viskov remarked. "There isn't much here I find aesthetically pleasing. The roses remind me of home."

"Life in Moscow is difficult?" Straker asked, sarcastically.

"This world is difficult," Viskov replied with feeling.

Straker was silent for a moment. "You want a private understanding between us, or you wouldn't be showing off your flowers," she finally said. "So I'll be brutally frank. Is the general secretary an idiot? When you succeeded Gorbachev, we were very pleased. Even if you were formidable and mysterious, you were regarded as levelheaded and restrained, a leader with a subtle touch. Now, I am not so sure. If I'm to have an understanding with you, I must know why you've erased thirty years of relative stability, to go adventuring in Iran."

Viskov laughed. "Don't you know?"

"I've read the intelligence reports. A balance-of-payments crisis. The penetration of revolutionary Islam into the border republics. Eroding political power among the Great Russian minority. Solidarity among European and Asian minorities, and the collapse of Gorbachev's experimental consumer economy. Alarmist predictions by GOSVOK, the State Bureau for Social Research. The poor general secretary, victimized by growing panic in the higher echelons of the Communist Party. Poor Viskov, shoved aside in an in-house putsch by the military command, after he dares oppose a military solution." Straker scowled.

"You have doubts?" Viskov asked mildly.

"I have suspicions. Your comeback after the *Venera* and *Viking* landers were found was quite a feat, wasn't it? As though you'd planned the whole thing."

Viskov laughed again. "But, Madam Secretary! It is exactly as you have told it! I was a victim of deviant militarism and indoctrinate political infighting, but through the fortuitous intervention of aliens from outer space, I was able to reclaim my position and aid Soviet patriots everywhere in effecting an end to the subversion of peaceful Soviet foreign policy. In fact, the world, brought to a wider perspective of the human place in the Universe, has decided to join with the Soviet Union to develop space technology. We shall need it,

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should these visitors decide to return to our world."

"Enough. I've already heard your speech."

"You believe it is not the whole story, perhaps?"

Straker stared at the general secretary.

He shrugged. "Did you know, Ms. Straker, I am almost eighty-five? Not many people do, and I am fortunate to be so well preserved. In my eighty-five years, I don't think I've ever had a diplomat speak to me as you have. I salute you for finding the courage to stake international relations on a dialogue of complete candor. I ask you the question you asked me: is the secretary of state an idiot?"

Each gazed at the other, struggling not to smile first.

Viskov spread his hands wide, palms outward. "Consider . . . if we can reach certain agreements here, we could cement a stable and mutually beneficial accord. Think of what we might accomplish together, in the atmosphere that is prevalent today."

Karla Straker stood silently, her hands at her side, staring at the roses. The hedges and bushes undulated in the wind like sentient, alien creatures with articulated eyes—red and pink, orange, white, and yellow.

Watching her. They were watching her. She turned away.

"Oh," she said, softly. "I understand."

She looked at Viskov. "It's not impossible to modify a VKS-3 long-range shuttle for interplanetary missions, is it? What would it take? Extra fuel tanks, extra crew modules, substantial alterations to maneuver in the Venusian atmosphere, of course. You lost two of them a year ago, even so. We knew about that, but we didn't know how. On Venus? What did you do? Retrieve the Venera and Viking landers yourselves?"

"Ms. Straker, please—"

She pointed a finger in his face, a knife holding a strange beast at bay. "The metal plaques were a deft touch. Stylized representations of a visit to our stellar system, made of alloy compositions cast in a zero-gravity environment. Tell me . . . how did you manage to get the *Viking* lander through U.S. customs? Never mind. I suppose it was easy enough."

"Ms. Straker, I must deny—"

She clenched her fist. "You deliberately created a crisis in Iran . . . to do what? Put us in the right frame of mind, by scaring the shit out of us? So you could do what?"

Viskov merely shrugged. "It's your guess, Madam Secretary."

"You're a *dreamer!* Viskov, the ruthless pragmatist, who throws people away when he is done with them, and settles international disputes simply by making threats. My God, you manipulate American politicians at will, myself included."

Straker spread her arms and let them fall to her sides. "And for what? Soviet hegemony? No! *World peace!* Viskov is a *romantic idealist!*"

"I must deny everything you've said," Viskov answered softly. "Except the part about wanting world peace, of course."

Straker laughed bitterly. "You'll win the Nobel Peace Prize, you know. For a hoax that murdered a million people."

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"I deserve it," he said.

CONSENSUS

Emily Hibbard was thirty-seven years old, with the same blonde curls and enormous grey eyes. She had a child from a broken marriage, a teenager now, and a home in Florida near Cape Canaveral. She was eccentric and stubborn, prerequisites for her position as systems-design director for the first manned interstellar vehicle, the *Union Explorer*, under construction in orbit around the Moon.

"My mom is really weird," her daughter would tell her friends. "I mean, she wants to live on Alpha Centauri, or somewhere. She got the idea when she was a kid. Can you *imagine* what she was like in high school? How *sick!*"

"I don't understand her!" Emily would complain to her own friends. "What does she want to do, hang around the beach for the rest of her life, until her boobs sag down below her knees? She flunked her calculus exam. *Flunked* it. She's got to get serious soon, or she'll end up pregnant and sitting in front of the television in some guy's mobile home. She doesn't *listen* to me!"

In truth, mother and daughter were very much alike.

The visitor standing in Emily's outer office one October day surprised her. Six years before, at the pinnacle of power, he had abruptly resigned and disappeared into the Siberian wilderness.

He was over a hundred years old, no rare phenomenon anymore, but still the stuff of rumors and legends eddying out from his passage through four tumultuous generations. He seemed uninhibited by his age. His hair was white, and the skin on his face and hands had darkened to sunburnt umber. His smile, though not unfriendly, was subtle and bloodless. The intense blue eyes burned in faintly reptilian sockets. They did not appear to blink.

"I'm honored, Mr. Viskov," Emily said, shaking his hand.

"I've been traveling," he replied simply. "I'm interested in the *Union Explorer*. Does someone have time to show me around?"

"I'd be happy to."

The old man seemed unimpressed.

He displayed a unique comprehension, even for someone with his background. His questions were concise and relevant, and he seemed aware of the design-limitations, be it tricky fuel-mixing parameters in the propulsion converters, or the mathematical paradoxes inherent in interactive particle-shield generation at near-light velocity.

As he sat on the flight deck of a control module mock-up, he turned to her and said: "So. You are chasing off after extraterrestrials, is that the plan?"

Emily winced. The subject was delicate. Personally, she did not believe that the aliens really existed, preferring an alternate and somewhat scandalous assertion that the Soviet Union—this man in particular—deliberately engineered the Iran Crisis and the *Venera-Viking* event for political purposes. Officially, however, the story remained unchanged from the years when Viskov served concurrently as the head of the Soviet Communist Party and secretary-general of the United Nations. Emily

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never argued the matter. Ideological and economic justifications for the enormous emphasis on space technology and exploration sprung like roses from that muddy past.

She decided to be diplomatic. "Perhaps we'll run into them between here and the Centauri stellar system. But it's not very likely. Our primary objectives involve research and testing prototype technology."

"And if you *do* run into them?"

Emily shrugged. "Then there are procedures to follow. A political agenda of sorts. Perhaps *you* can tell *me*."

"Things will change dramatically," he said, fingering the flight controls. "But only in terms of new configurations, more complexity, and greater scales. The patterns of existence will remain the same. The dynamics of politics and extra-associative relations will be similar, even if the parameters are modified. You will be surprised at how much will remain as it is."

Later, as they stood outside in the subtropical sun, Emily decided to broach a sensitive subject.

"We've met before."

Viskov looked at her sharply. "No, I don't think so."

"I doubt if you remember. I was seven years old, and my parents took me to the Soviet Union on a business trip. We toured the Kremlin, and I got lost. You found me."

She smiled to cover her embarrassment. "We had dinner in your office. You were very kind to me."

Viskov's expression changed, the ancient lines and textures thawing. "I remember you."

He took her hand. "Look at you. Grown up now, and doing such work. I'm impressed. You've given me hope."

He squeezed her hand affectionately. "Tell me . . . am I still so different, after all these years?"

"As a matter of fact, you are!" Emily laughed and shook her head. "I don't know what it is. I usually have an idea what people are thinking about or feeling. But with you . . . nothing. It's odd, especially since I've become so dependent upon the talent."

"Ah. It still bothers you, then."

"No. I'm older now . . . less naive, perhaps." She laughed again. "You know, when I was in high school, I decided that you were one of the aliens. It made sense at the time. I read texts on astronomy because I thought I could figure out where you were from, and one thing led to another, and . . . well . . ."

She bit her lip and subsided, feeling even more embarrassed.

"And you became a physicist and now you are building a ship to go to Alpha Centauri," Viskov finished for her. "Imagine that."

"I guess so." She looked at her watch. "Listen, I have a conference in a few minutes, but I'd like to have you come to dinner tonight. To repay an old favor."

"Well . . ." Viskov thought about it. "Yes. I'd like that."

Inside her office, Emily slumped into a chair. "What is so strange about that man?" she muttered.

COLD WAR

Dawn showed the warship loaded into the enormous orbital elevator like a shell in a shotgun breech, the scarlet sunlight

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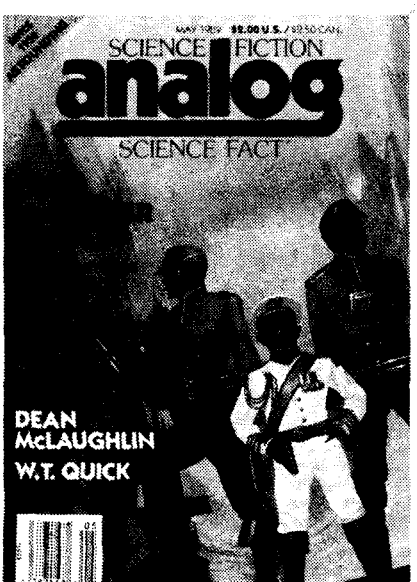

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descending along its polished superstructures and weapons turrets. Beyond the elevator sprawled a city, and shadows lay over the broad boulevards and chaotic architecture like a film of drying blood. Intermittent thunder rolled through the mountains above the city. The forested uplands stood out in stark relief against the dark rock, and each time a sheet of lightning exploded across the range the trees swelled and flared bright crimson before subsiding to milky grey-green.

Small, mindless creatures skipped and somersaulted along the boulevards, warbling plaintively. The wind matched their mood with the smell of sulphur-laden rain. Today the warship would be hauled into orbit to embark upon a mission that would take it beyond the confines of known space and, for a city that had struggled for two generations to build it, beyond time itself. The mission might take a hundred generations; soon, the city would be dismantled and torched. The heavy air muted the din of awakening life.

All was struggle. Though the technical advantages of a spacefaring civilization brought a mundane, day-to-day security, the struggle for survival merely measured itself on a greater scale. The issues were more complex, the arena was wider, the passage of events both deliberate and furious.

The ship, and the lives of those who had built it and would crew it, were but one gambit in that struggle. Born to a war waged over generations across interstellar distances, they fought without weapons, without spilling life. The adversaries, from further outward along the galactic plane, scrupulously observed the same unwritten contract. Both had met on an empty planet in a stellar system approximately equidistant from their home worlds, their representatives relieved to discover that no great gulf existed between respective technologies. Both had stayed to discuss the ramifications of their meeting, and how good relations might be encouraged without endangering either. The meeting place became a city dedicated to the ideal of accord, and later the nexus of crisis management as a war that was not a war flared all around.

Games were played while diplomats talked about the relative security to be found in the disadvantages of the situation. Interstellar transport was enormously expensive, and both civilizations were dependent upon an economic and cultural infrastructure spanning many systems. The loss of a few ships or a few planetary facilities might disrupt a delicate balance, as trade and communications were interrupted while materials and specialized equipment were diverted to rebuild them.

It was a matter of debate whether armed warfare was even possible. Strategic and tactical simulations had demonstrated the difficulty of engaging an unwilling adversary; cutting out and running was simple, inexpensive, and almost always advantageous. Tactical maneuver, in a perimeter of battle measured in generational expanses of time and space, seemed impossible.

The same simulations implied that strategies of attack and perimeter defense were costly and, in most cases, ridiculous. In the great majority of these scenarios, neither side won a clear victory. Both civilizations collapsed, as

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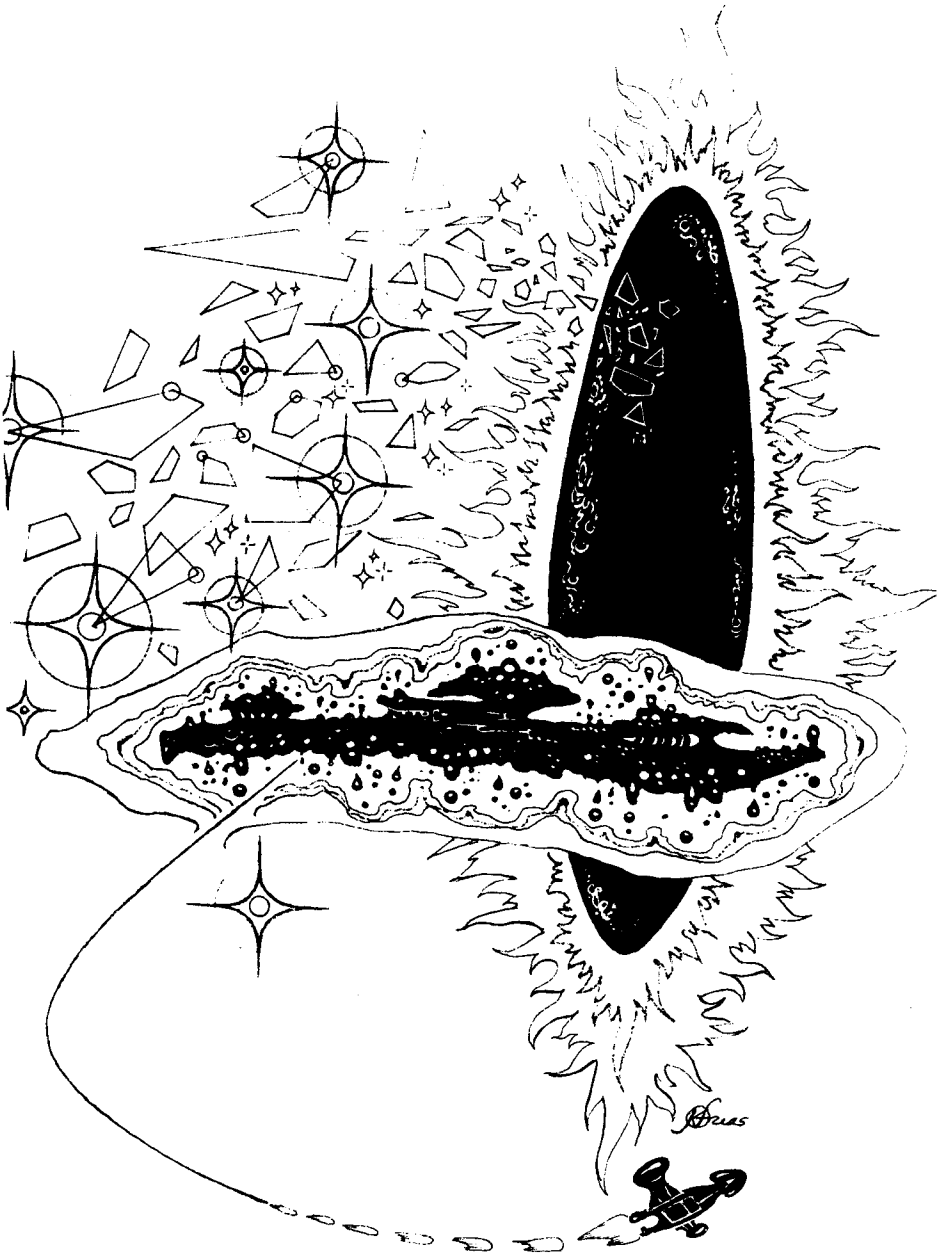

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production, transport and trade fell prey to external raids and organizational breakdown. Economic vitality disappeared, as governments tried to force societies into a wartime mode while artificially maintaining the high standards of living necessary for internal stability.

Even in the rare scenarios where one side or the other gained victory, no real advantage could be expected. With a damaged cultural and economic infrastructure, and with anarchy, bloodshed and refugees on their stellar "borders," they were forced into an expensive program of remilitarization and rigid economic and social control. Disintegration was the price of this policy. Victory was awarded to the civilization that collapsed last.

The naval analogy meant little in such an environment. Planets were not ports of call, nor islands in a sea of stars. Ships were not set pieces of military power, extending control over territorial waters or lanes of traffic.

Interstellar warfare was more akin to a game of guerrilla chess. There were axiomatic strategies, complex flanking maneuvers, even creative sacrifices. But territory and control had no meaning. Elements of both sides could pass through stellar regions freely, with little chance of armed interference. Planets were strong points, but only in a social or economic sense. Virtually impossible to defend, they were like villages in the bush—sources of supply and psychological motivation to opposing mobile units who moved and checked each other in the hinterlands beyond. War promised the nightmare of anarchy and nothing else: Planetary civilizations would be destroyed first, leaving self-sufficient military forces to fight on for generations, for no apparent reason, to no apparent gain.

The game shifted to another plane: economic and demographic competition. Each side attempted to gain advantage by opening up new systems to colonization and exploitation, and securing direct lines of transport and communication. Each side embarked upon rigorous programs of exploration to learn as much about the surrounding universe as possible. Intelligence was the only possible coin of competition.

The warship looming over the city was a tool of intelligence. Those who labored on it knew that outward along the galactic spiral arm, beyond known regions, widely-scattered stars dribbled out to nothing. Time, fuel, expense, and lack of profit might restrict both species to the central regions of the galaxy for millions of generations. The way out, the path which expansion must eventually take, lay towards the galactic core.

The warship, a shell in a shotgun, pointed towards the heart of the galaxy. It was more than a ship; it was a world in itself, virtually self-sufficient. The crew would be family.

Small creatures sang. Trees swelled sympathetically, some releasing their seeds to the rising wind. People poured into the boulevards and moved towards the massive pylons anchoring the orbital elevator to earth, wailing a dirge of farewell. The bright refractions of the red sun on the broken horizon lit their dark, vermilion faces and glittered in their iridescent eyes.

The warship orbited the heart of the

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galaxy, well beyond the accretion disk spiraling around the maw of an enormous black hole. The way was blocked. The great vessel, heavily shielded by a thick hull and multiple particle-shield generators, had reached the limits of its design. Radiation blew out from the regions around the churning event-horizon, filling space with gauzy, twisting sheets of flux and gravitational gradations, and the detritus of ripped and roasted atoms. Probes died in the maelstrom.

"What am I looking at?" the crew leader asked.

"Life," the second answered.

A screen showed a small, red star, a glowing coal in the darkness. Its face was mottled by roiling gas and deep, cold fissures, and, in one place, violet-colored spots sprinkled randomly across a darker, disturbed region. The spots moved slowly in convoluted patterns.

"No."

"Subatomic particles in a high state of agitation," the second remarked. "Held together by a remarkable lattice of field-fluctuations I don't even pretend to understand. Each individual is the size of a small moon."

"Life?"

"They remain stable as conditions change around them. They feed . . . they're absorbing matter and spectral emissions right now, and apparently they've set up reactive processes to generate higher energy states on the surface of the star. They move. The execution is precise and efficient. They breed. There are three times as many of them down there than when we discovered them. They communicate. We're receiving patterned emissions across the spectral bandwidth, as well as measurable gravitational perturbations. I look at the data, and I have the impression of life. I can't ignore it."

"Life," the crew leader repeated.

"I've taken liberties with the word," said the second. "Not organisms, not life as we define it. Perhaps the evidence can be explained in purely non-animated terms, but I doubt it."

"Just here? On this star?"

"We've surveyed sixteen infested stars in regions beyond the accretion disk. The statistical parameters indicate a higher population density further in towards the disk. Because of their structural characteristics, we believe the disk may be their point of origin."

The ship orbited far beyond the black hole, parting lengths of time like a rock cutting through sluicing waters. Data-dumps from heavily-shielded probes directed towards the event horizon trickled in. The accretion disk was saturated with "life." It displayed an incredibly complex structure, a virtual breeding ground for "avatars" that were flung out from its matrix in huge gravitational tides or glowing streams of stellar debris.

"Amazing!" the crew leader commented, as an avatar of exotic particles spun in and "ate" a probe. "We must try to communicate."

"You might as well talk to the clouds in the sky," the second answered. "Listen, we can compare planetary environments with our adversaries back home. We share the concepts of pleasure and pain, birth and death. The fact that we can compete on equal terms indicates a high number of parallel traits

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and broad social-psychological compatibility. Even if we don't share the same genetic patterns or early evolutionary schemata, we do share similar environments, and we've developed similar behavioral strategies for coping. We have a basis for communications. We have none with these creatures."

"At least we should try to attract their attention."

One minute the heavily shielded shuttle hovered a short distance above the tumultuous stellar chromosphere, roughly where the churning plasma graded into something denser. The next minute the vessel lay inside a lattice of exotic particles, a shivering sliver of metal that rapidly lost its shape.

In a soundless concussion it detonated, raining fire on the seething surface of the star. The gauzy lattice surrounding the blast fell apart and wafted away like smoke.

Shock rebounded through the warship, entombing the surviving crew in sorrow and surprise.

The second spoke first. "There is another problem. We've lost contact with most of our probes along the accretion disk. My analysis suggests they've been systematically destroyed."

The crew leader wheeled around and stared at the second. "You mean—"

Someone suddenly called: "They're massing just below the photospheric discontinuity. Look! There are thousands of them coming up from the interior of the star!"

The red star rapidly lost its color and shape. A violet hue spread like a stain across its surface. Borne up by tremendous eruptions of ionized gas, the avatars sailed through the photosphere, converging on the warship.

"We're under attack," the crew leader remarked with surprise, after watching for some time. The star looked like rotten fruit, the avatars like maggots wriggling up and away, leaving a trail of gaseous slime.

The chase spanned significant parts of the galactic core, as ages passed. The warship's course zigzagged above and below the galactic plane, through the core, and around its perimeter.

"Most of the stars of the inner core must be infested," the second observed.

A relatively short distance behind the warship, an amorphous wave-front of orbiting neutrinos, antineutrinos, and even more exotic "fast" particles traveled at or near the velocity of light. Under magnification and spectrum analysis, the wave-front resolved itself into millions of articulated high-energy structures.

"They're not going to let us escape," the crew leader said.

"Yes," the second agreed. "We've stayed ahead of them only by programming random evasive maneuvers. They'll run us down eventually. They're capable of traveling at near-light velocities indefinitely."

"We can't go back," the crew leader said bleakly. "We'll lead them in with us, and that will be the end of everything."

"We must get this information home," the second insisted.

"We won't survive this encounter," the leader told the assembled crew a short time later. "Yet it is imperative

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that we warn our people. We don't know whether these creatures are inimical to all organic life, or even if they realize that we are, in fact, alive. We're not even certain if we're dealing with sentient intelligence, or merely animated instinct."

The crew leader paused. The thick, dark membranes around its breathing vents rasped in the dry air. "If we present them with a hundred targets instead of just one, we've multiplied their problem. I'm ordering the remaining shuttles to be prepped for interstellar ranging, and launched at random vectors towards all parts of the galaxy. Those of you who are shuttle crew must evade these creatures if possible, and then vector for home."

As the meeting broke up, the crew leader caught the second by a broad, leathery shoulder. "You go, too. Alone, aboard the fast transport. It's small and well protected, and you are very good."

Time stormed by as the second crawled through the void. Only two had followed the transport as it broke away from the warship so long ago; one caught up midway along an unexplored spiral arm, and weapons had flared like small novae. The avatar finally disintegrated into random streams of particles, but at great cost. The other hung back, biding distance while the second watched various onboard systems slowly degrade.

The second spent most of the time in stasis, but the ship had awakened it now. Weak signals trickled in from a stellar system up ahead, a yellow star with a large number of planets. At first the signals appeared of natural origin, difficult to distinguish among the emissions of an active gas-giant orbiting fifth out. Later, the computer verified that the patterns were artificial, generated by organisms with a low order of technology.

The second's inclination was to leave the matter alone. The avatar had different ideas, however. When it diverged from a common vector, trailing off towards the source of the signals, the second knew indecision.

"We'll have to reach an accord with our enemies," the crew leader had remarked. "We'll have to dismantle a way of life, and rebuild together to face this threat. I feel stupid. I knew how small our concerns were, relative to the framework of the cosmos itself. But I had no idea the comparison was anything beyond a philosophical exercise."

Pursued by a Minion of the End of All Things, the second had stumbled across a third civilization of sentient organisms. What to do? They would be helpless before the avatar's onslaught.

The second had no illusions. It decided as it did because it knew the transport would not last much longer, and it needed help. *In a universe of space and dust and indiscriminate cold, organic sentience is grounds enough for cooperation*, it told itself. Altruism, cooperation, pragmatism, and selfishness are linked together at the core of such life.

The second caught the avatar as it orbited in towards the third planet, like a glowing comet from the void.

CONVERSATIONS WITH A DINNER GUEST

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MOM,

ALEX IS HAVING A PARTY ON THE BEACH TONIGHT. I PROMISED HIM I'D COME. I'LL BE HOME BY MIDNIGHT. LOVE YOU.

JANIE

"Dammit!" Emily Hibbard said irritably, crumpling the note in her hand. She had hoped she would not have to face Viskov alone over dinner tonight.

"Doesn't she have homework, or something?" she groused, as she rummaged through the kitchen shelves for spices.

At one minute after seven, the doorbell chimed. Emily put down the fork she was using to stir the eggdrop soup, and wiped her hands on a dish towel. She paused by a mirror in the foyer, and ran her fingers through her hair.

"Grey," she said, scowling. "Soon."

She turned and opened the front door.

An enormous figure hidden beneath a cape and a hood waited on the step. For a moment it seemed to examine her, and then withdrew a large, double-jointed hand from inside the garment.

The skin on the hand was thick and vermilion-colored, Emily noticed. She suddenly felt dizzy.

The figure pulled its hood away from its face and stared at her, iridescent blue eyes possessing an unblinking intensity.

"You invited me to dinner," it said, in a deep, uneven voice.

Emily leaned against the door.

"I guess I did," she finally replied. "Do you eat . . . Chinese?"

Later, as Emily curled up on the sofa and the massive alien sat placidly on the living room floor, the front door opened. Janie skipped down the hall and halted by the portal.

"Hi, Mom! Alex brought me back to get some money. We're going for pizza."

She looked down at the figure on the floor and frowned. "*What?* . . ."

Abruptly, she laughed. "Another weird boyfriend, Mom? Who's this? You two going to a Halloween party this weekend?"

"Janie—" Emily began.

"Never mind, Mom, you can tell me about it later. Alex is really hungry." She paused, glanced at the alien. "Great costume. *Void Fiends*, right? I've seen that movie."

Then she was gone, the sound of her feet trailing upstairs.

Emily turned back to her guest. "Well . . . I can't really call you Viskov, you know."

"Call me whatever you like. Call me . . ." The alien imitated a shrug. "Bob."

"*No!* I mean . . . Bob was my ex-husband's name."

"Oh," the alien remarked mildly. "Whoops."

"It's all right, it's all right. Really."

"You shouldn't be nervous, you know."

"I shouldn't be nervous?" She stood up and waved her hands. "I invite the most distinctive international leader of the last century to my house for dinner, and he turns out to be a big *lizard!* My daughter sees him and thinks he's my boyfriend! I shouldn't be nervous, everything's just *fine!*"

* * *

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"I fought the thing at close range for days, in synchronous orbit above the dark side of the Moon," the alien explained. "I was losing steadily."

Emily leaned forward, balancing a can of beer in her hand.

"The shields were in good shape, so I took a calculated risk. I maneuvered inside its field-lattice and detonated several antimatter micro-bomblets at near-zero proximity. The explosions demolished my navigational and sensing clusters, but they were enough to disrupt the thing. It fled, and I pursued it, into the upper atmosphere of this planet."

The alien waved a hand. "I destroyed it, twenty kilometers above the Siberian wilderness. It made quite a mess down there . . . and generated some scientific folklore, as well."

"And you stayed here," Emily observed.

"My ship was beyond repair. I salvaged what I could into a small planetary lander and blew the hulk. I came down in Siberia, just beyond the area of devastation. . . ."

"Viskov was an analog, you know . . . a cybernetically enhanced human approximation, tissues grown in a tank. His prototype was a real person, a Russian priest I traveled over the world with."

"A priest? How . . ."

The alien licked its thin, black lips. "It isn't pleasant. The man's brain was modified by surgically removing several areas of the cerebral cortex, and implanting an autonomous microprocessing unit with an adaptive, goal-seeking program, as well as some very sophisticated communications equipment. I lay in stasis in a cave in Siberia, my mind linked to the processor by digital transmission."

The alien shrugged. "Viskov was better. He had a molecular-hardened, tungsten-steel skeletal chassis, polymer-fiber musculature, and a sophisticated sensing network. In fact, he was human only in superficial appearance. He had skin and hair, and a rudimentary set of organs for effect—lungs, digestive tract, an enzymatic system designed to promote slow aging."

"Where is he now?"

The alien glanced at Emily. "There's another Viskov—a replicated human physique, carefully crafted to appear dead of natural causes. It lies on a beach near here."

"I don't understand."

"Organisms die. It is well beyond Viskov's time, and questions were being asked. Before he died, however, I wanted to directly assess the work done on the *Union Explorer*. I have a personal interest in the project, you see. . . ."

"I have no way of communicating with my home," the alien said. "The core is interposed between your spiral arm and my own, and signals won't carry through. Either I must go myself, or get to a point along the rim where transmissions can pass unhindered."

Emily finished off her fifth can of beer. "So build a ship, and . . . take off."

"You should stop drinking that stuff," the alien said. "Achieving the technology required for interstellar travel takes resources of a planetary scale, and you know it. I could do nothing with human technology as I found it. All I *could* do

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was wait, and do my best here and there to foster a suitable environment for large-scale technical development."

"You're being clever," Emily said, tossing the can on the carpet. " 'Do my best here and there . . .' You ran the whole damn show for sixty years."

"I made use of political circumstance. Everyone does."

Emily shook her head. "I'm not drunk enough."

" 'All is struggle,' " the alien said, staring at the crumpled beer can in its fist. "That is what we told ourselves. A struggle to find security in a probabilistic universe, one in which there are no absolutes, only quantum phenomena. You can't find security. You can only create better odds."

The alien looked up. "I created better odds, by managing Soviet-American competition, then ending it. I want to create even better odds, by ending the war between my people and the others, and by allying our three species in another conflict."

Emily wrapped her arms around herself and sat back. "That's not a profoundly comforting message, you know. I don't like your universe very much."

"Why not reveal yourself?" Emily asked. "Lead us openly."

"Human beings are proud, and pride inspires," the alien answered. "Pride inspires enormous creativity, and enormous insecurity. Both suit my purpose entirely."

"What happens afterward?" Emily asked. "The galaxy is big, and it might take millions of years to contain these things. Humanity might be extinct by then. Your people as well."

"I see an end," the alien replied, reclining on the carpet and clasping its hands behind its leathery head. "It's a question of origins—yours, mine, the avatars. I've thought about it for years. I believe—more by intuition than reason, I'm afraid—that the avatars are like viruses of chaos . . . quantum particles of entropy within the macrostructure of the cosmos itself. They consume matter and energy, reproducing themselves exponentially while forming an irregular, spherical wave-front that spreads outward from a single point . . . leaving nothing inside but a state of disorder."

The alien gazed at the ceiling. "Perhaps this is the way it begins and ends, and begins again. A universe that consumes itself and is reborn. Perhaps the expanding sphere of avatars will distort along the curvature of space until it reaches a topological state at which it begins to contract over upon itself. Perhaps the avatars, countless numbers of them, will return to their place of origin, crowding mindlessly together towards the black womb. Eventually their rate of gravitic compaction will reach an infinite set of values, collapsing down to a singularity, an incalculable point at which the familiar characteristics of physics no longer apply. A universe may be born out of the stuff of that singularity, in an unimaginable surge of incandescence. . . ."

The alien lifted an orange from a basket of fruit Emily had brought in from the kitchen.

"I shouldn't eat these things; they

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make me feel sick," it said. "But I like the texture."

It popped the orange into its mouth and ground down hard on it, peel and all. Juice and seeds spilled over its lips and onto the dark cape.

"That was fun," it said.

It picked up a paper towel and dabbed at its face. "If you think about it, the conflict is as much a struggle between two ideologies as a struggle for survival."

"What do you mean?" Emily asked, staring at her own orange.

"The ideology of science, yours and mine, values the disciplined quest for knowledge and wider experience. Perhaps the greatest applied benefit of that knowledge is the ability to order matter and energy in creative and utilitarian ways."

Emily put the orange down. "I see your drift. We fit into the natural scheme of things. What are we, the antibodies of Order? Quantum particles of conservation and symmetry to balance those of entropy? Are you proposing a war between Chaos and Order?"

The alien nodded. "One would force the cosmos along rigid and cyclically determined patterns, while the other might ultimately liberate the cosmos by turning it into an infinite and organic work of choice and individual will."

Emily picked up another can of beer. "You realize what you're describing, don't you? A dialogue between good and evil."

"How old are you? I mean, non-relativistically speaking."

"Twenty-two thousand orbits of the World of Our Origin around its sun," the alien replied. "Nine thousand years. My world orbits close in to a small red star. It's cool by your standards, and while it has a complex environment derived from the presence of oxygen and water-ice, the biosphere is not as varied as your own."

"And the others?"

"Termites," the alien replied, attempting a laugh. "A close analogy. They developed on a temperate world orbiting a yellow star, very much like this one. They are committed to their social hierarchies and die if separated, so interstellar expansion has become a part of the ritualized practice of reproduction."

"Why did you reveal yourself to me?"

The alien did not answer.

"Why?" Emily asked. "Are you going to kill me? Have I interfered with your plans in some way?"

The alien inclined its great head.

"No," it said. "I came to say thank you. When someone secretly lives among strangers, as a stranger, it can be painful. You sensed something of what I am, and I am grateful."

Janie sat beneath the low dunes, feeling the breakers crash on the beach. The wind keening through the coarse grass had a vast and brittle quality, and the Moon in the empty sky seemed swollen and close.

A lantern lay in the sand beside her, its dull orange light gleaming faintly in the alien's iridescent eyes.

"Oh . . . hello," Janie said, looking up.

"How do you feel?" the alien asked.

The girl shook her head, and pointed

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listlessly with her hand. "He's dead. I don't think he was drowned or shot, or anything. He was just old."

"I think you're right. Did Alex go for the police?"

Janie nodded. "He looks familiar, but I can't remember."

"His name was Viskov," the alien said softly. "He was a friend of your mother's."

"Really? Oh . . . that's sad. Mom'll be sad. She's getting older, you know. She worries about it. I used to think it was so stupid."

She looked back at the body. "Now, I don't know."

"We don't get along very well," she finally said.

"You get along with her," the alien remarked. "You don't realize how well."

"You think so?" She shook her head. "I can't talk to her."

"Try."

Janie grinned lopsidedly. "As simple as that?"

She fell silent. After a while, she shivered. "I've never seen a dead person before. It makes me feel funny."

"Your mother will understand that," the alien suggested.

When the police arrived, Janie looked around for the man in the monster costume. He had disappeared.

"He was a really nice guy, Mom," she said, much later. "Didn't you like him?"

CONTAGION

The old woman picked her way carefully up the talus-littered incline, to the base of a granite wall. The tall pines blocked out some of the sunlight; the shadows beneath were cool, and the air smelled moist and slightly bitter.

The woman paused, and looked back. Men and women stood atop several armored personnel carriers, a few hundred yards down the slope. They watched her through binoculars.

She looked up along the granite face. Swallows had made their nests in its fissures. She could hear the cries of their young.

"Hello?" she called. "Are you there? I want to talk to you!"

She sat down clumsily on a rock and listened.

"It's important!" she said, finally.

She sensed movement behind her, and as she turned, the alien stepped from behind the trunk of a pine. Exclamations floated up from the people below.

The alien held up a hand. "Yesterday, soldiers appeared in the flats. Why have you broken your word, Emily?"

"Nice to see you again, *too!*" the woman said, irritably. "Where are your manners?"

The alien inclined its head. "Why are you here?"

The woman took a deep breath, and held it for a moment. "A week ago the Aimes Research Center received a data-dump from an unmanned probe in the Tau Ceti stellar system. It was the last of the preliminary survey vehicles to down-link before we sent out a manned expedition."

"Yes?"

"Tau Ceti is infested."

A shrill cry cut through the air from above. A hawk, drifting along the warm rock wall, had suddenly snatched a sparrow from a ledge, and bore it, struggling and shrieking, into the bright sky. The

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remaining birds chattered violently, then fell silent.

"When I heard about the anomalous data, the things you described immediately came to mind," she continued. "I used my emeritus status to gain access to the project, and when I had seen enough, I went to the director."

She smiled harshly. "He thought I was senile. But the more the Tau Ceti team analyzed the data and argued about the meaning of it, the more sense my story made. Then somebody thought to access the Soviet information archives, and learned about the strange red creature people had occasionally reported in the district where Viskov spent the last years of his life."

She leaned over and put a brittle, parchment-covered hand on the alien's massive arm.

"I have grandchildren now. I have great-grandchildren, and I love them. Those *beasts* are four parsecs from Earth, or less."

She withdrew her hand. "Andrei Nikolayevich. The Security Council and the Advisory Commission of the Academy of Sciences want to consult with you. Will you return with me to New York?"

The alien stood silently for a moment. Then, picking up the frail woman with one hand, it trudged down the talus slope.

DIASPORA

Before the last shuttle lifted, the alien insisted on spending some time at the cemetery near the beach.

"I will only be an hour, no more," it promised.

It took a sheaf of roses—many different colors—in one hand, and a Hibbard great-granddaughter in the other, and walked up the sandy path with that peculiar swaying motion that had become so familiar to humanity.

It wandered among the headstones until it stood in front of a particular one, where it set the child down on her feet, and laid the roses across the grave.

"Do you know where we are?" the alien asked.

"It's Gramma Emily's place, where she sleeps," the girl lisped, wiping her nose with a fist.

"Do you remember her?"

The girl nodded, very seriously.

"Would you sit here with me for awhile, while I remember her, too?"

She smiled, and raised her arms.

It was impossible to make a stand on Earth, of course. The necessary knowledge and technology did not exist, nor the time to attain them. Not even the alien had a sense of the final forms of combat; answers lay in a distant future. The only practical option was to buy time by running away.

Even to develop the capability of running had been a tremendous struggle; asteroids had been snared and hollowed out, and fitted with vast living quarters, stasis chambers, propulsion reactors and shield generators, all in the space of several decades. The material quality of human life declined drastically amidst the economic and social hardship of the period, and the fact that humanity managed to hang together was a feat rivaling the enormous engineering effort.

The avatars were decoyed away by an elaborate network of broadcasting drones, powerful bombs set to detonate

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in different stellar quadrants to attract attention, and even volunteer crews who ran—and perhaps were still running—evasive patterns out into deep space. Hope arose when the beasts were found to be more instinctual than analytical. Late reports indicated that Sirius and Wolf 359 were infested, with some activity in the vicinity of Alpha Centauri. Time was very short now, and the great stone arks of humanity already were lifting slowly above the plane of the ecliptic and scattering, to meet years in the future at a rendezvous point on the outer edge of the galaxy.

Not everyone chose to leave. Not even half.

The alien held the little girl in its arms. Overhead, heavy clouds scudded across the evening sky, their edges tinted orange, their bellies blood red.

"Are we going away now?" the girl asked.

"Yes."

"Are you going to come with us? Please?"

The alien played with her hair, looping the blonde curls around its thick, vermilion-colored fingers.

"I'm always going to be with you," it said. "Imagine that."

The Message, when it reached the people of the Red Sun at last, arrived on the lips of the second—only survivor of the warship—who stood on the bridge of the lead arkship of a fleet of thousands, each filled with aliens wondrous and very strange.

The Message taught the ultimate Cosmology of Struggle. . . .

●The only knowledge that can hurt you is the knowledge you don't have.

Anon.

●Defeat is not the worst of failures. Not to have tried is the true failure.

George E. Woodberry

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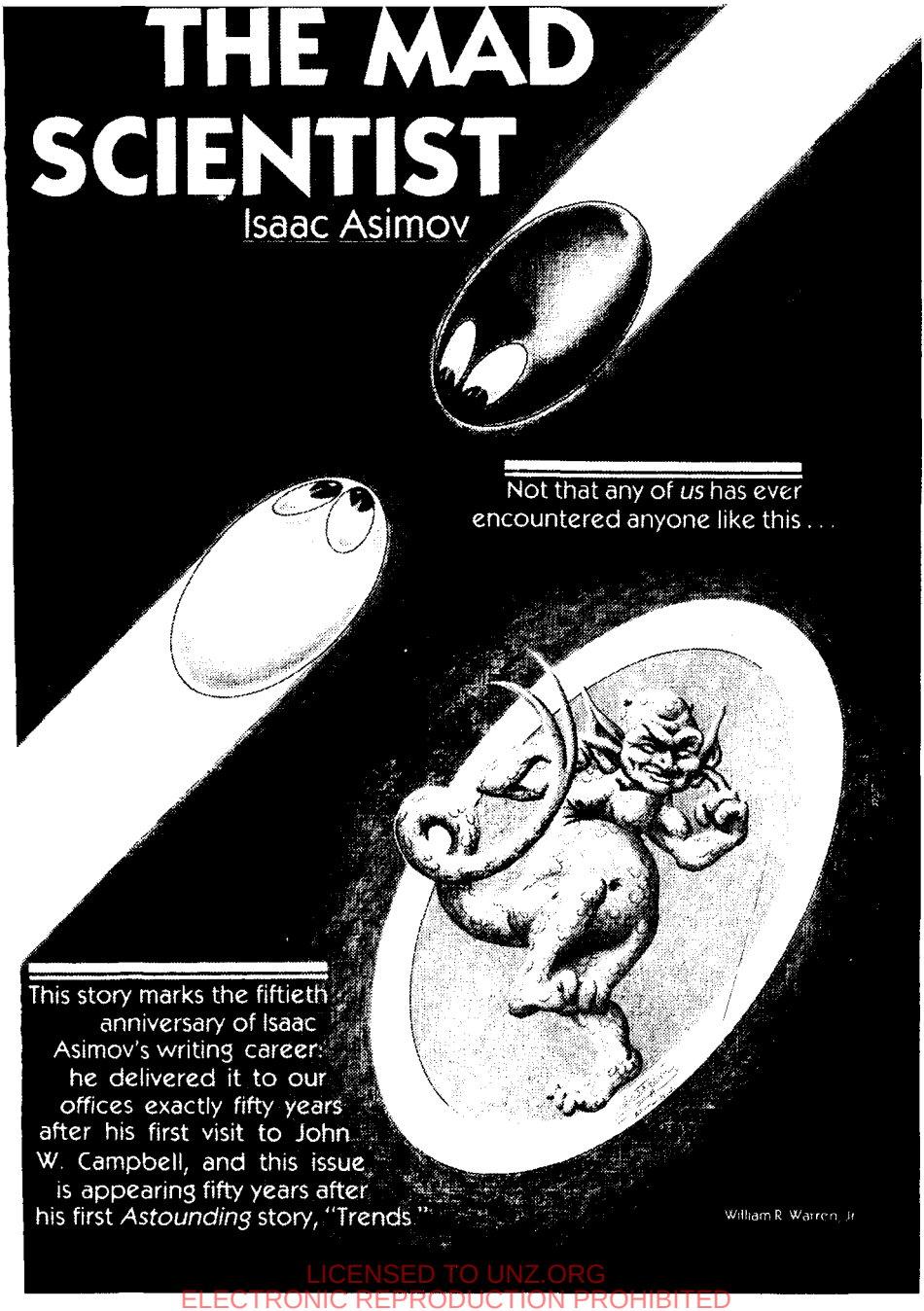
THE MAD SCIENTIST

Isaac Asimov


Not that any of *us* has ever encountered anyone like this . . .
This story marks the fiftieth anniversary of Isaac Asimov's writing career: he delivered it to our offices exactly fifty years after his first visit to John W. Campbell, and this issue is appearing fifty years after his first *Astounding* story, "Trends."
William R. Warren, Jr.

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George and I generally meet at some neutral spot—in a restaurant or on a park bench, for instance. The reason is simple: my wife won't have him in our apartment because she thinks he's a deadbeat—and I agree. In addition, though, she's immune to his charm and I, for some reason I can't fathom, am not.

However, my dear wife was out for the day and George knew that, so he dropped around in the afternoon. I couldn't very well turn him from my door so I invited him in with what enthusiasm I could muster. That wasn't much because I had a deadline staring me in the face and a set of galleys that had to be read.

"I hope you don't mind," I said. "I have to finish this thing. Why not help yourself to a book and read for a while?"

I didn't really think he would. He glared at me for a moment, then pointing to the galleys, said, "How long have you been making your living that way?"

"Fifty years," I mumbled.

He said, "Isn't that enough? Why don't you quit?"

"Because," I said, speaking very distinctly, "I have to earn enough money to support those of my friends who constantly devour their meals at my expense."

I meant it to sting, but George is immune to such things. He said, "I should think your brain would shrivel to a peanut, spending fifty years writing stories about mad scientists."

I was the one who was stung. I said, rather sharply, "I don't write stories about mad scientists. No one in science fiction above the comic-strip level does it. Mad scientist stories were written back in Neanderthal times; they are not written now."

"Why not?"

"Because, George, they're old hat. And on top of that, the madness of scientists is a base canard accepted only by the hopelessly banal and cliché-ridden. There are no mad scientists. Some may be genially eccentric, perhaps, but never mad."

"Really," said George. "I knew a mad scientist once. Martinus Augustus Dander. Even his initials were mad. Ever hear of him?"

"Never," I said, and fixed my eyes firmly on my galleys.

"I didn't say he was certifiable," said George, totally ignoring my galleys, "but any dull, respectable, uninteresting person—you, for instance—would consider him mad. I will tell you his story—"

"Later," I said, a note of pleading entering my voice.

I see that despite your amateurish attempt to appear busy you are all agog to hear the tale (said George), so I will not tantalize you with delay, but get right to it.

My good friend, Martinus Augustus Dander, was a physicist. He had gained his Ph.D. in physics at Mudlark University in Tennessee, and at the time that all this took place he was Professor of Physics at the Flatbush Correspondence School of the Physical Sciences.

I used to have lunch with him at the school cafeteria which was located on the corner of Drexel and Avenue D near a falafel pushcart. As we sat on the stoop

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and ate our falafels, or occasionally a knish, he would pour out his soul to me.

He was a brilliant physicist, but a bitter man. My own knowledge of physics stops short about the time of Newton G. Descartes so I can't judge his brilliance as a matter of first-hand knowledge, but he told me he was brilliant, and surely a brilliant physicist can recognize brilliance when he sees it.

His bitterness arose from the fact that he was not taken seriously. He would say to me, "George, in the world of physics, everything depends on your connections. If I had a degree from Harvard and taught at Yale, or at M.I.T., or at CalTech, or even at Columbia, the world would hang on my every word. But I must admit that a Ph.D. from doughty old Mudlark and a professorial seat at Flatbush C.S.P.S. carries a somewhat lesser weight."

"I take it Flatbush isn't part of the Ivy League."

"You are quite right," said Martinus. "It is *not* part of the Ivy League. What's worse, it does not have a football team. But then," he added defensively, "neither does Columbia, and yet I am ignored. *Physical Reviews* will not publish my research papers. They are brilliant, revolutionary, cosmically significant," (it was at this point that his eyes got that peculiar glint that would lead prosaic people like yourself to consider him mad) "but they are rejected not only by *P.R.* but by the *American Journal of Cosmology, the Connecticut Bulletin of Particle Interactions*, and even the *Latvian Society of Impermissible Thought*."

"That's too bad," I said, wondering if he would be willing to pay for an additional yam knish, which this particular pushcart produced à la française. "Have you tried a vanity press?"

"I admit," he said, "that I sometimes feel desperate, but I have my pride, George, and never will I pay to have my world-shaking theories published."

"What, incidentally," I asked, with faint curiosity, "*is* your world-shaking theory?"

He glanced furtively from side to side as though to make sure that no colleague was within earshot. Fortunately, the only people present were some seedy individuals exploring the contents of neighboring trash cans, and a keen glance seemed to convince him that none of these were members of the Flatbush C.S.P.S. faculty.

He said, "I can't give you the details, of course, since I must maintain my priority. After all, my academic confreres, while souls of integrity in most ways, will, without hesitation, steal any man's intellectual property. I will, therefore, omit the mathematics and merely hint at the results. You know, I presume, that sufficient energy sufficiently concentrated, will bring about the production of an electron and a positron or, in a more general sense, any paired particle and antiparticle."

I nodded sagely. I had, after all, inadvertently glanced over one of *your* science essays at one time, old man, and had gathered something of the sort.

Dander went on. "The particle and antiparticle curve off in response to an electromagnetic field, one to the left and one to the right, and if they are in a good vacuum, they separate indefinitely without reconversion into energy, since

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in that vacuum they do not interact with anything."

"Ah," I said, following the little fellows off into the vacuum in my mind's eye. "Very true."

He said, "But the equations governing this action work in either direction, as I can prove by a very subtle line of argument. In other words, it is possible to create a particle-antiparticle pair, well separated, in a vacuum—without any energy input, of course, since in the forward motion they produce energy. In other words, we produce unlimited energy out of the vacuum, fulfilling the dreams of every human being who has ever longed for Aladdin's lamp. Indeed, I can only assume that the genies who filled medieval Arabic legendry knew of my theory and applied it."

—Please, old man, don't interrupt me with pompous outcries to the effect that this is impossible because it would require a reversal of time or the violation of both the first and second laws of thermodynamics. I am merely reporting what Dander told me, and I do so without elaborate editorialization.

Now to get back to my story—and, yes, my feathers *are* ruffled—

Upon hearing what Dander had to say, I commented thoughtfully, "But, Martinus, my friend, what you are suggesting would imply either that time is reversed or that both the first and second laws of thermodynamics are violated."

To which he replied that, on the subatomic level, time *can* be reversed, and that the laws of thermodynamics are statistical rules that do not apply to individual subatomic particles.

"In that case, my friend," said I, "why do you not tell the world of this great discovery of yours?"

"Indeed?" said Dander, sneering elaborately. "Just like that? What do you suppose would happen if I buttonholed a fellow-physicist and told him what I have just told you. He would babble of time-reversal and thermodynamic laws as you do, and rush off. No! What I need is to publish my theory in full detail in a prestige-laden journal of hoary scientific repute. Then people will pay attention."

"In that case, why don't you publish—"

He did not allow me to finish, "Because what stuffy, flannel-brained editor or referee would accept any paper I write that is in the least bit unusual? Do you know that James P. Joule could not get his paper on conservation of energy printed in a scientific journal because he was a brewer? Do you know that Oliver Heaviside could not persuade anyone to pay attention to his important papers because he was self-taught and used unconventional mathematical symbolism? And you expect that I, a member of the lowly Flatbush C.S.P.S., can get *my* paper printed."

"Too bad," I said, with a manly sympathy.

"Too bad?" he said, throwing off my arm which was resting on his shoulder soothingly. "Is that all you can say? Do you realize that if I could only get my paper printed, people who studied it would see exactly what I mean and would greet it as the greatest elaboration and application of quantum theory ever advanced? Do you realize that I would surely receive a Nobel Prize, and that I would be canonized right alongside of

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Albert Einstein. And only because no one in the scientific establishment has the courage and the wit to recognize genius, I am doomed to lie in an unmarked grave — unwept — unhonored — and unsung."

That touched me, old man, although I admit that I hadn't the faintest idea why Dander objected to being unsung. What good it would do his dead body to have a rock group caterwaul over his fresh-turned grave, I can't imagine.

I said, "You know, Martinus, I can do something for you."

"Oh," he said, with a faint touch of bitterness in his voice. "You are perhaps a second cousin of the editor of *Physical Reviews*; or your sister is, perhaps, his mistress; or you are, perhaps, privy to the exact manner in which he succeeded to his post, following the suspicious—"

I raised an austere hand. "I have my methods," I said. "I promise I will get your paper published."

And I did, for it so happens, I know how to contact a two-centimeter extraterrestrial being, whom I call Azazel, and whose advanced technology makes it possible for him—

[Oh, you *have* heard of him. Is it possible that I have warned you before of the dire consequences to yourself were he to hear you add your fatuous *ad nauseam* to your statement?]

In any case I contacted him and he arrived in my apartment in his usual high state of dudgeon. He is, of course, a small being compared to the human beings of our planet and he is, in point of fact, even smaller compared to the intelligences on his own world, all of whom, I have gathered, have long curved, sharp horns as opposed to the little nubbins sported, to his incredible embarrassment, by Azazel. It is to the unhappiness arising from his size and his pigmyish equipment that I attribute his fiery temper. A person of my broad understanding can sympathize with his situation, and even approve of it, since his frustrations are useful to me. After all, he grants my requests only because it is his chance to shine as a being of accomplishment, something that never happens on his own world.

In this case, though, his fury vanished as soon as I had explained the situation.

He said thoughtfully, in his high-pitched squeak. "Poor fellow. He finds himself at odds with editors, does he?"

"I'm afraid so," I said.

"I am not surprised," said Azazel. "Editors are fiends, one and all, and it is a worthy task to get even with them after being at odds with them. It would be a happier, a purer, a more fragrant world," his voice rose into a sudden passionate outbreak, "if every editor were buried under a huge heap of stinking *maradram*, though that, of course, would make the smell worse."

I said, "How is it you know so much about editors?"

"Why," he said, "I once wrote a tender little short story, fragrant with true love and redolent of sacrifice, and an incredibly stupid—" He broke off. "Do you mean to say that on this backward mudball, you have editors of the same sort we have on our own advanced world?"

"Apparently," I said.

Azazel shook his head. "Truly, in fundamentals, all intelligent societies

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are alike. We may differ in all superficialities, such as biological makeup, mental attitudes, moral sensibilities, but in the true basics—the characteristics of editors—we are alike."

(Yes, old man, I know that you have no trouble with editors, but that's because you grovel.)

"Is there anything you can do, O Mighty One and Universal Power, to correct the situation," I asked.

Azazel thought. "I must have some indication of the psychic makeup of some particular editor. I presume your friend has a—you should excuse the expression—rejection slip from some editor."

"I am convinced of that, Great One."

"The wording and aura of that slip would give me the information I need. A slight adjustment of that aura, a drop of the milk of human kindness, a soupçon of intelligence, a trace of tolerance— We can't expect to make a moral beacon of an editor, to be sure, but we can mitigate the evil just sufficiently—"

Well, it is not my intention to go into the nitty-gritty of the techniques of Azazel; it would be dangerous to do so in any case.

Suffice it to say, I had obtained a rejection slip from Professor Dander by a clever piece of strategy that involved picking the lock of his office and going through his files. I then persuaded him to re-submit his paper to the journal from whose august offices the rejection slip had come.

In fact, old man, I used a little trick I had once picked up from you. I said, "Dander, my friend, send this paper back to that black-hearted incompetent and write a covering letter that reads as follows, 'I have made all the changes suggested by the referee and it is incredible the extent to which these have improved the paper. I am grateful to all of you for your help.' "

Dander objected feebly at first, pointing out that he had made no changes and that the statement was not, therefore, an objective description of the actual circumstances. I explained to him, however, that what he needed was a publication and not a Boy Scout badge.

He thought about that for a while, and then said, "You're correct. A Boy Scout badge would be most inappropriate since I never actually qualified for Scouthood. I flunked tree-identification."

Off went the paper and two months later, it was published. You have no idea how happy Martinus Augustus Dander was. We bought enough skewered meat at the sidewalk cafeteria to blister our stomachs and then downed it in drink after drink of orange crush à la ptomaine.

[Please stop nodding your head, old man, and reaching for your dreary galleys. I have not finished the story.]

It was about that time I spent a winter with my friend who owned a house in the country; the one whom I taught to walk on snow. I believe I told you the story. For that reason I did not see Professor Dander for some three or four months.

I sought him out at once on my return, however, for I was certain that by now he had completed preliminary negotiations with some Japanese firm for manufacturing energy out of nothing, and

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that he was rolling in pelf of large denominations. I was certain he would be in no mood to skimp and that a dinner at Burger King was well within the realm of practicality. I had even brought a bottle of my own special ketchup-mix in anticipation.

I found him in his office staring blankly at the wall. He had a three-day growth of beard, and his suit looked as though he had slept in it for three nights although he himself looked as though he had not slept at all for four. It was a paradox I did not attempt to unravel.

I said, "Professor Dander, what has happened?"

He looked up at me, with lack-luster eyes. They focussed only slowly and a look of near-comprehension entered them by microscopic stages. "George?" he said.

"The same," I assured him.

"It didn't work, George," he said, feebly. "You failed me."

"Failed you. In what way?"

"The paper. It was published. Everyone read it. Each person who read it found a mathematical error in it. Each person who read it found a *different* mathematical error. You deceived me, George. You said you would solve my problem and you didn't. There's only one thing I can do now, George. I added up the food bill at the street-corner cafeteria. You owe me $116.50 in pizza slices alone, George."

I was horrified. Once my friends start adding up bills, who can tell where it would end? Even you might bestir yourself, despite the difficulties you have in doing sums.

I said, "Professor Dander. I did not deceive you. I told you I would see to it that you had your paper published, and that I did. I promised nothing more than that. It never occurred to me to guarantee your mathematics. How could you expect me to know that your mathematics had fallen short?"

"It didn't." A certain indignant energy crept into his voice. "It did not fall short."

"But those professors who found errors?"

"Fools, one and all. They know no mathematics."

"But each one found a different mistake."

"Exactly." His voice was almost normal now and his eyes were beginning to glitter. "I should have seen this before. They're incompetent. They *must* be incompetent. If they knew their mathematics, they would all have found the *same* mistake."

And then the glitter faded and an air of hopelessness pervaded him again. "But what's the use?" he said. "They've destroyed my reputation. I've been made a laughing stock. Unless— Unless—"

He sat up suddenly and seized my hand, "Unless I can *show* them."

"How do you expect to show them, Professor?"

"So far I have only a theory, a line of argument, an intricate mathematical demonstration. That is something one can argue with, and supposedly disprove. But if I can actually produce my particles and antiparticles. If I can do it in significant quantities and create substantial amounts of energy out of nothing—"

"Yes, but can you?"

"There must be some way. I'll have

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to think—think—'' He bent his head between his two fists. ''Think,'' he muttered. ''Think.''

Then he looked up at me, eyes narrowed. ''After all, it's been done before.''

''It has?''

''Absolutely. I'm convinced of it. Eighty years ago, some Russian must have worked out a method for obtaining energy from a vacuum. Einstein had just established the quantum theory in 1905 by his work on the photoelectric effect, and from that it followed—''

I won't deny that I was skeptical of this. ''What was the name of the Russian?''

''How should I know?'' said Dander, indignantly. ''But he must have created a mass of particles here on Earth and an equal mass of antiparticles in space beyond the atmosphere, just as a demonstration. They curved toward each other and met in the atmosphere. That was in 1908 in Siberia near the Tunguska River. It's called the Tunguska Event. No one was able to figure out what had happened. Knocked down every tree for forty miles but left no crater. But *we* know what happened, don't we?''

He had gotten quite excited and had gotten to his feet. He was hopping about and rubbing his hands. He was babbling in his enthusiasm, saying, ''The Russian, whoever he was, deliberately experimented in the middle of Siberia to avoid damage and he was undoubtedly killed in the explosion. Nowadays, though, we have ways of conducting experiments with radio signals at long distances.''

''Dander,'' I said, quite shocked. ''Surely, you don't intend to conduct dangerous experiments.''

''Oh, don't I, though?'' he said, and an expression of pure evil came over his face. That's when the madness truly began to show. Remember that I told you he was a mad scientist.

''I will show them,'' he shrieked. ''I will show them *all*. They will see whether energy can be obtained from a vacuum or not. I shall create an explosion that will shake Earth to its foundations. Laugh at *me*, will they?''

Then he suddenly turned on me, ''Get out, you! Get out! I know very well you are trying to steal my ideas, but you won't. I will cut your heart out and mince it to mush.'' He snatched at some sharp-edged instrument on his desk and rushed at me, continuing to babble.

Well, old man, let it never be said of me that I did not know when I wasn't wanted. I left with the dignity that becomes me so well—running slightly, of course.

I never saw Dander again and he is no longer at the Flatbush C.S.P.S.

And that's my story of the mad scientist.

I stared at George's face, with its look of bland innocence.

I said, ''When did all this happen, George?''

''Several years ago.''

''Of course, you have a reprint of Professor Dander's paper?''

''No, old man, as a matter of fact, I haven't.''

''A reference, perhaps, to the journal in which it was published.''

''I haven't the faintest idea, old man. I don't interest myself in such trivia.''

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"I don't believe you for a minute, George. When you tell me that this mad scientist of yours is somewhere attempting to arrange a huge collision of matter and antimatter, I tell you it's all nonsense."

"For your own peace of mind," said George, calmly, "you had better continue to think so. Nevertheless, somewhere in this world, Dander is busily working. From his last incoherent remarks, I gather he was planning to create a Tunguska event, long distance, over the lower Potomac. He pointed out that next to the middle of Siberia, or possibly the Gobi desert, Washington, D.C. was the most dispensable place on Earth. Of course, its destruction will convince what's left of the government that the Soviets have struck and they will retaliate at once so that the resulting thermonuclear war will destroy the Earth. —I wonder, therefore, if you could lend me fifty dollars till the first of the month, old sport?"

"Why should I?"

"Because if Dander succeeds, money will have lost all value and you will have lost nothing. Or to put it another way, you will have lost everything, so what's another fifty?"

"Yes, but what if Dander doesn't succeed?"

"In that case, in your relief at knowing that all humanity will survive, will you be so small-minded as to cavil at a mere fifty dollars?"

I gave him the fifty. ■

●The great thing in the world is not so much where we stand, as in what direction we are moving.

O. W. Holmes

●Logic: the art of thinking and reasoning in strict accordance with the limitations and incapacities of the human misunderstanding.

Ambrose Bierce

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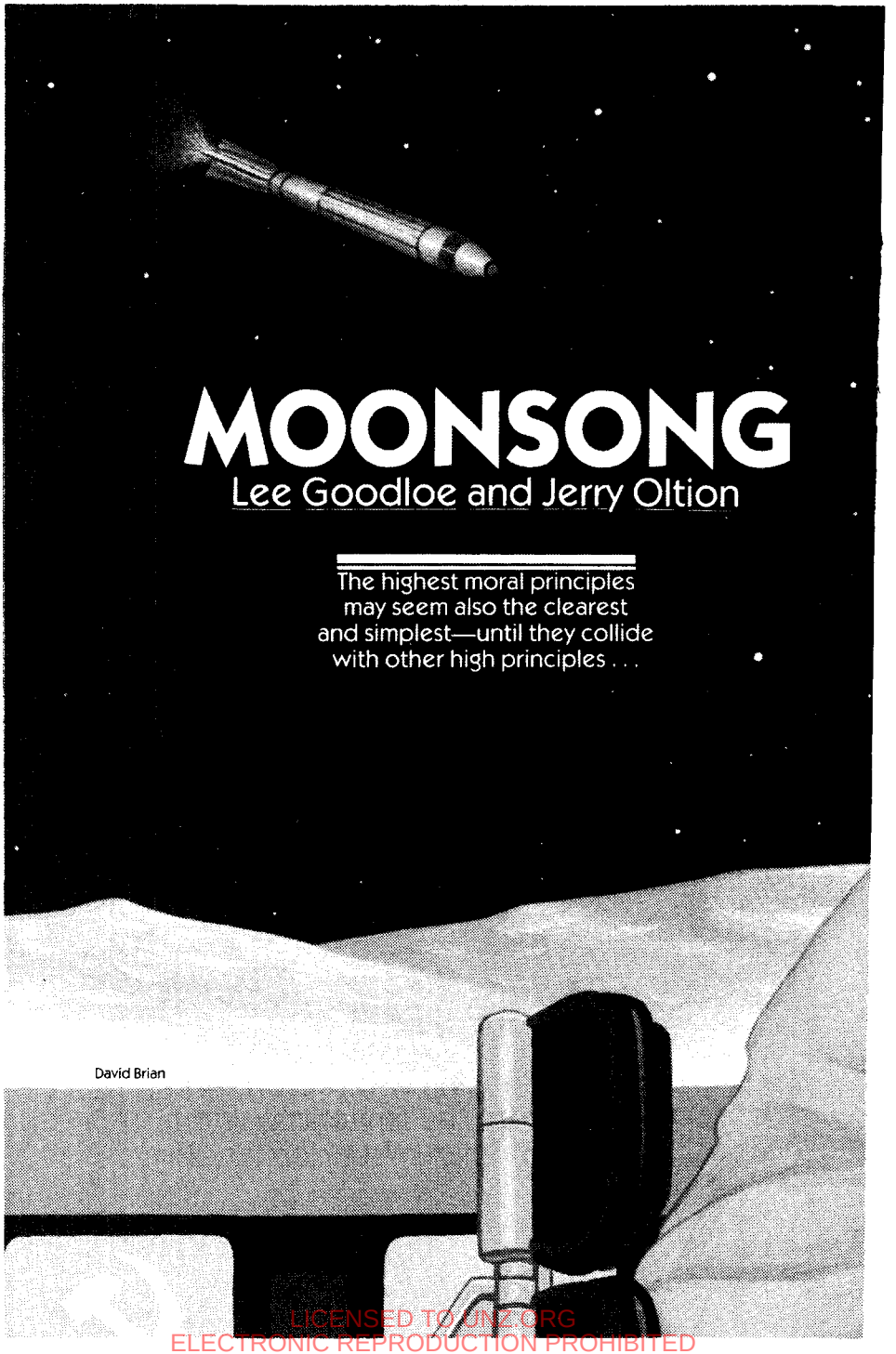

MOONSONG

Lee Goodloe and Jerry Oltion

The highest moral principles
may seem also the clearest
and simplest—until they collide
with other high principles . . .

David Brian

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Aleksey Lvovich Yevshenko toyed nervously with his radio receiver while he waited for the Moon to rise. He glanced again at his watch. Five minutes, according to the ephemeris. A pale glow to the east showed where it would be coming up. He sighed and tried to relax, but he couldn't shake the feeling he was being watched.

It was almost like watching a pornographic video, nervously glancing around to see who was watching *you*. You *knew* someone was a *Chekista,* you just didn't know who. But they couldn't tell he was listening to the lunar station, could they? Ha. Aleksey was not so naive as that, to believe they couldn't if they wanted to. His only security lay in anonymity; if they didn't suspect anything, they wouldn't bother.

The lunar station would have news on the Ukrainian situation. And, of course, *Pravda* had said nothing about it . . . *V Pravde pravdy nyet* . . .

Crackle, then a voice. The signal came in loud and clear—too loud! He frantically turned the volume down.

Richard Salas was reading copy into the microphone. He hated reading copy and he hated doing it in Esperanto even more, but this was the first time tonight for this particular story. He was recording as he read; after this time he would dub it on the cart with the other stories and let it repeat with the rest.

"And also in the news tonight," he read, trying to make it at least *sound* ad-lib, "another in *The Daily Planet*'s continuing series of special reports on government protection: deep space warheads. Yes, *amikoj,* in violation of more treaties than you have fingers, your governments have placed a *bunch* of warheads in deep orbit, beyond the Moon. Don't *you* feel safe, with all those deep, dark missiles protecting you?" Richard winced at the phrasing—when would Jason learn you *don't* talk down to an audience?—but read on. "Isn't it nice to know that your governments' zeal to defend you isn't inhibited by a simple United Nations treaty? Of course, we'll name names. Stay tuned. Details coming up."

A red light winked at him from a meter-wide holographic globe suspended behind the control board. Richard stopped reading, hit the pause button on the tape deck, and said into the microphone, "Oho! Looks like we've got another jamming attempt, and surprise, surprise, tonight's static comes to you courtesy of, let's see—" he spun the palm ball on the console to rotate the blinking point into the high-magnification window and read the name on the map "—looks like Frankfurt. So we just up the directional power a megawatt or so for you folks there in Germany—" he pressed a well-worn button labeled *jam over,* set in a breadboard box duct-taped to the top of the console, and the winking light turned amber, then green as the computer compensated for the ground interference. Richard continued without a pause, "—so shorten your antennas, *amikoj!* And give us a call if you still can't hear us. Ha. So what do you suppose your government doesn't want you to hear tonight? Well, we'll tell you, but first a reminder: Download Hour will be coming up at 0700 UT. The latest system software, the latest public domain material, the latest public data. All right here on *MoonSong,* 108

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megahertz, 19200 baud, no parity. As always, we respect copyright, but we do not respect suppression.

"Now a brief word from our sponsor, then out with the dirty laundry. . . ."

"Alyosha! *Chto delayesh?*"

Aleksey started violently, looked up from his receiver. Larisa Ilinichna, his wife of less than a year, stood in the doorway, her nightgown rumpled from sleep, a frown spreading across her face.

"Uh, tuning in Kiev?"

She smiled once, fleetingly, then said, "Alyosha, you're going to get us in big trouble if you keep listening to that thing. You read that article in *Pravda.*"

"Trouble," he said with a shrug. "*Da,* trouble. Always with the threat, our fearless leaders. Well we must not give in to threats. When they can convince me it's *right* not to listen, then I'll turn it off."

"It doesn't matter if they convince you or not, Aleksey. They say listening is not right, and they mean what they say. It's not worth arguing with them."

"Are they so threatened by the truth?"

"It does not matter, Aleksey!" Larisa was becoming agitated. "Why risk our life style, even our lives, over this! And there's also my career . . . I have enemies who would *love* for the *Chekisty* to find something."

"Ah, yes, your career." Aleksey's voice acquired a hard edge. "The top-notch design engineer, in the top-notch laboratory, doing top-notch work for the State. The pearl for the *otlichnitsa* from the Technical Institute. And the director thinks highly of you, too." He couldn't resist that last dig, but he regretted it the instant he said it.

"You seem to like this *dacha,* the car, the special stores, Aleksey Lvovich!" she hissed. "If I did not work where I do, do you think we'd be able to live like this? Do you think *you'd* live like this? You are not a member of the *nomenklatura!* And remember, Stepan Maksimovich is a powerful man. I could end up in a Kamchatka research station, or worse, if he decided I belonged there. And so could you! You can do what you wish, but I am not going to risk that!" She stomped out.

Something disproportionate about her anger . . . Aleksey shook his head. Women! It was not really so big a thing. But he shouldn't have mentioned the director. He grimaced to himself. Yes, Stepan Maksimovich was a powerful man, yes, they lived well because of his fondness—Aleksey couldn't admit to himself it was more—for Lara. Yes, he could put up with it, for a while, anyway. The Soviet system trained one to endure. But he didn't have to like it.

The word from another sponsor was winding up. An avuncular voice was declaiming " . . . and the Islamic Liberation Front wants justice. That is all. The justice denied us for decades. We are not cruel, and we are not the animals this station has made us out to be. We regret the methods to which necessity had forced us, but we regret even more the methods used against us, to oppress and enslave the innocent—a side of the story that, unfortunately, this station did not present.

"Justice. That's all we want."

A moment of dead air, then Richard's voice again: "The preceding was a paid

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political announcement. *MoonSong* stands ready to broadcast any and all points of view, to any and all points of the Earth. For information, contact our advertising office. Call Luna 7-123-7777, or write us at *MoonSong*, South Sea Freeport.

"Our rates are reasonable, and our audience is a planet. Again, that was Luna 7-123-7777, or write us at the South Sea Freeport. Freedom of information, working twenty-five hours a day."

Richard Salas continued with his news show, *The Daily Planet:* "Coming up this hour: details on corruption in Africa, with a story on the good Marxist profiteers who sell the grain intended for the starving. As always, we have names, dates, and places.

"We have the time and kilotonnage of the United States's latest nuclear test, which it denies carrying out.

"We have on-the-spot coverage of the *Jihad* in the Mideast, bypassing the Islamic news blackout. Bodies for Allah!

"Also coming up: a special tonight on the ferment in the socialist brotherhood of nations, the purge of Ukrainian 'revisionists' and other folks who dare to think for themselves. Not quite so spectacular as burning heretics, unless of course you happen to be one of the thinkers. But first, missiles in space."

Aleksey cursed softly. If Salas gave the stories in that order, it would be well over an hour before he got to the Ukrainian situation. Larisa would never let him listen that long. *Gospodi!* But he wasn't prepared to quit yet, not after the scene just now. A part of his mind also acknowledged that his clandestine radio sessions were a defiance to keep his self-respect. Stepan Maksimovich did not own him completely. Not yet.

Salas's voice continued. "The Outer Space Treaty of 1967, to which the space powers were signatories—" he paused ironically "—prohibits the placing of weapons of mass destruction in outer space or on the Moon or another celestial body. 'Weapons of mass destruction' is diplomat-speak for nuclear bombs, *amikoj*. This means no nukes in space, agreed to way back in 1967. Well, way, *way* back in 1914 when Germany invaded Belgium at the start of World War I, Kaiser Wilhelm said Germany's treaty with Belgium was just a scrap of paper, and it looks like the Kaiser's spiritual heirs are with us still.

"Apparently the 1967 treaty is just a scrap of paper, too, *amikoj*, 'cause just about every government with the capability has put nuclear bombs in orbit.

"Let's review the use of space around Earth. Since the dawn of the Space Age, most artificial satellites have circled the Earth well inside the orbit of the Moon. As you know, there are two main places for artificial satellites, the first in low Earth orbit, right above the Earth's atmosphere, and the second in 24-hour geosynchronous orbit, 36,000 kilometers above the Earth. That's about one-tenth the way to the Moon.

"But *The Daily Planet* has learned there's now another preferred place for artificial satellites: way out beyond even us. These orbits run every which way —some even at right angles to the Moon's orbit—but none of these satellites ever come closer to the Moon than 50,000 kilometers.

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"What are *these* satellites? you ask. A good question.

"They're not scientific. You don't need a swarm of satellites, *all* so far from Earth, for legitimate scientific research. One or two will do.

"They're not for communications. They don't stay in lockstep with the Earth, like the satellites in geosynchronous orbit. And they are so much farther from Earth their transmitter power would have to increase ten or twenty times for you to even hear them. Furthermore, it takes radio waves a good two seconds to get there, a good four seconds to get there and back. That's an awfully big time lag to try to carry on a conversation. You might as well send a letter.

"No, *amikoj*, these satellites have no legitimate purpose. They are for one thing, and one thing only. They are for war. They are bombs, orbiting nuclear bombs, autonomous bombs, with built-in rockets and guidance.

"Why hasn't anyone seen them before? Another good question. It's true, they're dark. The very latest in stealth technology keeps them hard to see, both with ordinary visible light and with radar.

"But maybe someone has seen them, and they're not talking. It seems strange, with all those telescopes on Earth, that nobody's reported so much as a thin streak in a photographic plate. Surely some astronomer thought he discovered a new planet. But I guess you have to protect those government grants. Can't blame the scientists for not wanting to bite the hand that feeds them, can we? Well, maybe we can, but that's another story.

"Now, you're no doubt asking, *why* would your governments go to such effort and expense to install bombs in deep space, bombs their own agreements long ago outlawed? We asked the same thing, and what we came up with is this: They're up there because of the institutionalized paranoia that still engulfs humanity's home planet. They're up there to finesse the uneasy stability of the last half century. These bombs are offensive weapons, *amikoj*. The defensive shield of anti-ballistic missile weapons that now surrounds the Earth is helpless against these deepbombs. The ABM shield is designed to protect against missiles fired from *below*. It isn't designed to protect against missiles arriving from *behind* it, appearing swiftly out of deep space.

"And swiftly is the key word here. These bombs have ion propulsion drives, drives that are low-power and very hard to detect, but that can thrust for a long time. If targeted back to Earth, these bombs will be traveling over fifteen kilometers per second by the time they cross the shield layer, far faster than a surface-launched ballistic missile, and far harder to shoot down—even if you're looking in the right direction to begin with."

Aleksey listened, chilled yet enthralled. He was a communications technician for the shuttles supplying the Soviet lunar base; orbital mechanics and targeting were his forte.

"If you could even see them to shoot them, that is. Again, these deepbombs are fitted out with the very latest in stealth technology. They're very hard to see. *We* found them, because we have access to state-of-the-art astronomical

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instruments and lots of time. An Earth-orbit defense laser will have neither."

And you also have your spies, Aleksey thought wryly, but Salas was much too savvy a newsman to say *that* on the air.

"Scientists pointed out, decades ago, Earth's civilization could not survive a major nuclear war. So these bombs are sheer lunacy, just one more example of the insane antics of governments.

"We at *MoonSong* hope, still, that humanity can survive its self-appointed protectors. And we hope those of you on the home planet will let your governments know what you think of this outrage. And which governments are we talking about? It's a big list, but you know who's on it: anybody with both the Bomb and rockets. The United States, obviously, and just as obviously the Soviet Union. China, Japan, *all* of the European space powers, the Afri-space coalition, Australia, India—I don't need to read them all. It's simpler to read the one single exception. That's right, there's just one nation in the whole world with space capability that *hasn't* planted its own deepbombs, and that's us. South Sea Freeport has no deepbombs. We, at least, practice what we preach.

"We're *MoonSong,* representing Freeport and all humanity. Freedom of information, working for you twenty-five hours a day. We respect personal rights, but we do not respect suppression.

"Next, Africa, but first, this."

A sexy female voice, distorted as if by telephone, replaced Salas's. "Of course I want you," she breathed. "Haven't I been trying to tell you that all week? But don't bother to come over without your Slickers. I mean it."

Aleksey felt himself redden. Crazy American commercials! Was nothing too much for their capitalistic attention? First they invented the plague—at least if *Pravda* was to be trusted at all they had—and then they made money preventing its spread. The sheer audacity of it! But he had to admit, their advertisement definitely got your attention . . . .

Larisa's hand seemed to come out of nowhere. The radio skidded off the table, crashed to the floor, and died in a clatter of broken plastic.

"Enough! Come to bed, now!"

Aleksey stared at the broken pieces for a moment before he stood. He faced her squarely, but the angry outburst he'd intended to deliver never made it past his lips. Instead he reached out and drew her into his arms, saying, "Lara, you're white as a sheet! What is it?"

"Damn it, Jason, I'm not running a Sunday School! This stuff reads like a schoolmarm's lecture! How many times do I have to tell you this patronizing pap you serve up is the wrong approach?"

Jason Thomas looked up from a freshly transcribed report on the American CIA's latest attempt to topple the government of Nicaragua. He was a stocky man in his sixties, whose full head of brown hair belied his years. Billionaire industrialist, owner and director of not only *MoonSong* but of the entire nation of Freeport, he controlled nearly all non-government access to space. It had been his idea to buy a surplus oil drilling platform, plant it on an isolated seamount in the South Pa-

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cific, and call it a sovereign nation. When that had developed into the biggest spaceport in the world, he had then indulged his fantasy of a "free-information" radio station. They'd just recently been able to move it to the Moon, a much more advantageous—and much less vulnerable—location than Freeport.

Ingrid Nilsson, *MoonSong*'s assistant director, looked up from her desk in the next office as well. Tall, blonde, fortyish, she was a striking woman; only faint wrinkles beginning around her eyes betrayed her years. She grinned at Richard through the open doorway, but prudently kept quiet, turning back to her computer screen as Jason sat up straighter in his chair.

"What now, Dick?" Jason said in a faintly humoring tone.

" 'What now, Dick,' " Richard mocked. "What now is the same as what always. You have no feel for audience presentation. You talk down to them. Worse, you make *me* talk down to them. If you want your scripts read verbatim, all you need is someone who can read. You certainly don't need a newscaster, especially if you reject his experience."

Jason pursed his lips and considered his fountain pen for a moment before he spoke. "Dick, I don't reject your experience. I value your opinion. It's just that in this case, you're wrong. You know radio like the back of your hand, but you know North American radio and that's a different breed. You're used to targeting your audience with slick, calculated hype, but that's not the way an international station works. That's *especially* not the way *MoonSong* works. We're here to provide the news in as clear and unambiguous a manner—"

"And as bland," Richard put in.

"—as possible. So it's bland. You're still thinking in American terms. What's come over the HotLine? Have you had a lot of complaints?"

Richard snorted. Jason had finagled a flat-charge international phone number—an UNdollar per call charged to the caller—for audience feedback. They had certainly gotten a lot of feedback, but . . . "The only people that actually call a station are ones with an ax to grind. Or, when you're playing music, horny thirteen-year-old girls. It's not a scientific sample, Jason. Most people, if they don't like you, will just switch stations."

"That's exactly my point," Jason retorted. "You North Americans are used to being *able* to change channels. In the East bloc you don't have that option. *Any* source of information is precious, and that's what we are. We're a source of information. Uncensored, free for the listening, and the only one around."

"It's easy to be arrogant to a captive audience, Jason."

"So what's the problem? We have a listener base. We have advertisers. Even the Americans dump money on us. We can *afford* to be arrogant, if that's what you want to call it. If we get competition we can fight it out in the common market, but until then we own the airwaves, and we can do what we like with them."

Famous last words, Richard thought, but he was arguing into a vacuum and he knew it.

* * *

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From *The Daily Planet:*

"The United States of America today categorically denied the placing of so-called 'deepbombs' in deep Earth orbit. 'Such a gross violation of treaty obligations is alien to our history, alien to our principles, and alien to our ideals,' a spokesman for the state department said.

"So what's out there, then, America? Aliens?

"Well, it pains us to contradict the bastion of democracy, but our devotion to the truth compels us to. We follow here with the size, orbital parameters, and estimated megaton yield of the United States's weapons, from direct on-site inspection. . . .

"Freedom of information, working for you twenty-five hours a day. We respect personal rights. We do not respect suppression."

From any point on the Earth's surface, the Moon rises about fifty minutes later each day, so there are about twenty-four hours and fifty minutes between successive moonrises. The reason for the lag is simple: The Moon doesn't wait for the Earth, but moves along in its orbit, so the Earth must rotate a bit more than one full turn to catch up again. The effect was hardly significant in terms of its effect on programming, but it did give the station a handy motto.

What really affected programming was the lunar month. Over the course of a lunar month, some 29.3 days, the Moon drifts backwards through the day, rising with the Sun when it is new but steadily rising later, fifty minutes per day, as its phase changes. Because of this, a lunar radio station's programming has to change systematically over the course of the month, from mostly daytime shows during new Moon to mostly nighttime shows during full.

Daytime programming has to be mellow; people don't listen to controversial or seditious material at work. So for two weeks *The Daily Planet's* outrageous newscasts and subversive fare, its trademark, took a back seat to music—a fact of orbital mechanics for which Richard Salas was exceedingly grateful. He was a news anchor, not a music jock; while *MoonSong's* other employees ran the station during the long "day," he could catch up on his reading. And on his sleep.

"Umm?" Larisa asked. She stretched, affecting the pleasant languor that follows lovemaking. But she didn't feel languorous. She felt tense, irritable, and —as always—soiled. She looked over at the director. He was not bad looking—indeed, he was not really a bad sort, just innocently selfish, and he really seemed to love her—but he was not Aleksey. Nor was his love any assurance of safety. Who knew what others he had dallied with before fixing on Larisa? *I do this for my homeland, for the Ukraine!* she thought furiously to herself, clutching her cause to her.

Stepan Maksimovich was reclining, eyes half closed, a contented smile on his face. He and Larisa were sharing the small couch in the director's inner office. Larisa was "working late at the lab," an excuse that was starting to wear very thin. Her colleagues smirked at her during the day, but no one had, as yet, said anything.

The Director said again, lazily, "Those

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hooligans on the Moon have gone too far now, Larochka. They told all about our deepbombs on their radio a week ago, and Pyotr Igorovich and Irina Borisovna told me today the decision has been made to eliminate this nuisance." The director was proud of his acquaintance with several Politburo members, and he liked to drop their names with studied casualness. Larisa had stopped being impressed long ago.

"Umm?" she said again, and then, as his statement registered, she tried to conceal her sudden interest beneath a posture of languid indifference. She needn't have bothered; the Director was oblivious as usual. He rattled on.

"They're not sure how; they're having Strategic Rocket Forces study their options. But they may use a deepbomb." The Director smiled broadly, his eyes still closed. "Just think, Larochka, one of *our* deepbombs. The Politburo will notice the laboratory that built such a useful device!"

"But won't the U.S. protect them?" Larisa asked, drawing him out.

"No, not this time." The Director chortled to himself. "They finally irritated the United States, too. The Americans also have deepbombs, and the Lunigans—" he used the artificial slang affected by the Soviet media "—told all about their bombs, too." He chuckled again. "One would think they would not bite the hand that protects them."

The Americans have deepbombs too?! Larisa thought. *We were told they didn't!*

"Well, the Politburo must know," she said aloud. "It will be amusing to see how the Lunigans squawk. *"Nu,* I'm getting cramped, Styopa. And I really should leave. I think Aleksey suspects."

"We can do something about Aleksey," the Director said, in a tone more hurt than threatening.

"We don't want that, Styopa. What will people think? We don't want a scandal!"

"Akh, da, I suppose you're right. But this cannot keep on forever."

That's true enough, Larisa thought wryly to herself.

"What are we going to do, Larochka?"

"Do, Styopa? We take the time we have, we enjoy the minutes we have, and we let the future take care of itself."

"Yes, yes, you're right as always. Women see these things so much more clearly. *Spakoinoi nochi, Larochka.'*

"Spakoinoi nochi, Styopuchka." She bent over and kissed him.

Larisa dressed and headed home. Once well outside the building, she furtively took a pen from her pocket and pressed the retractor just *so,* feeling the soft click that indicated the switch from recording mode to transmit mode. With the crawling sensation she always felt at such times, she walked across the lab grounds, momentarily stopping in an open area. Several small benches were scattered among the pines; the staff often lunched here summers. Now the Moon washed the conifers with pale light, which flickered strangely with deep shadow as a light breeze waved the limbs. Larisa paused as though enjoying the eerie scenery. She glanced at the source of that light, now in its first quarter and nearly touching the western horizon. There would not be time to find a safe place and rerecord

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the message. No matter. The people at *MoonSong* knew how she got her information. She looked around, yawning and stretching as she did so. She still clutched the pen in her hand, and as she raised her arms she surreptitiously flicked it. A high-frequency maser pulse flashed toward the Moon. *"Shche ne vmerla Ukraina!"* Larisa breathed, and continued on her way.

"Problems, honch." Ingrid Nilsson came in and set a folder down on Jason's desk. "Big problems. One of our most valuable deepthroats says the Sovs are out to get us this time, and the U.S. will make tut-tuttin' noises and let them. Our source says it'll probably be a deepbomb between our ears. I figure it'll be nonnuke; they'll probably try to call it a meteor strike. The Russkis could even have an independent investigation of the crater, to show there's no radioactivity. It'd be an awful convenient act of God, of course, but hard to prove otherwise."

"But we could just shoot it down," Jason said. "Couldn't we? If we know it's coming?"

Ingrid had a fast, breezy manner of speaking even when delivering bad news. She said, "You read your own news stories, don't you? There's nothin' we could do. Anything they send at us would be in maximum stealth mode, and movin' fast. Also, it'd probably be comin' in at low angle. Not to say there wouldn't be more'n one, too. In fact, we're one of the reasons they've been stashin' those things out there."

"Can't we preempt it then? I thought we located all those turkeys to do this news series."

"Well, yes, we think we've got them all spotted. But there are over a hundred of them out there, and even if we could get to them all, they can always put up more. They just wait till the launchin' site's facin' away from the Moon, and our Earth-orbit surveillance satellites can't watch everywhere. They could use a portable launcher easily enough. Or they could put one on the shuttle for their moonbase, for that matter. It'd already be aimed at us and everything."

"You're saying all we can do is sit here and wait for them to drop a bomb on us?"

"Not quite. I'm just sayin' we can't shoot it down. There are still diplomatic channels; maybe we can keep them from launchin' it in the first place."

"Diplomatic channels," Jason said disgustedly. "It's government we're *fighting* here."

"It always is, honch. Plain people don't often want to kill other people."

Jason managed a thin smile. "I guess that's why we're here, isn't it? Get the word out to the people, let them know what their governments are doing in their names. It just feels a little more—immediate—when it's our own skin on the line." He nodded. "All right, let's see if we can work up a story on it. Freedom of information." He echoed *MoonSong's* motto. "Let's shout about it. See if we can embarrass a few *people* into doing something about it."

First Quarter. The mix was about sixty to forty today, news and music, the music getting heavier as they drifted into night. Richard Salas *hmmmed* into the dead microphone, warming up his voice. From the production room across the glass, Fyodor Medvedev, known on

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the air as "Med the Red," was finishing his evening show. Richard listened to his patter with half an ear, going over his own story one more time while he waited. At last he heard Med say, "And that does it for today, *tovarishchi*. I'll be back again tomorrow with some *dikiy* new synths from a most unlikely place: West Afghanistan. Listen in! And now, bringing you the devil's own dirty laundry, the hottest scoops of the straight poop, here's *MoonSong's* own Richard Salas, with today's edition of *The Daily Planet*. Dick!"

Richard flipped his microphone switch on. "Thanks, Med. Good evening everyone, and welcome to *The Daily Planet*. No pun intended, but our headline story hits kind of close to home tonight." He paused for emphasis, then began reading. "It seems our story on deepbombs has provoked a response; *MoonSong* has recently learned several governments are conspiring to drop a deepbomb on *us*. *What* don't they want you to hear, *amikoj*, that they would use illegal weapons to shut us up?

"The spacefaring powers are given to waxing lyrical over the U.N. as the 'last, best hope of humanity.' By that they supposedly mean the U.N. provides a forum to air national differences before they escalate into war. We at *MoonSong* would like to know what they call dropping a bomb on us, if not an act of war. South Sea Freeport has filed a formal complaint with the U.N. anyway, but that won't accomplish anything and we know it. We need your help.

"We need cards and letters, *amikoj*. Not to us, but to your own heads of state. Mail them anonymously if you have to, but let your leaders know you won't stand for their entering into a war with us. Let them know what you think of deepbombs in general. If you don't want to use the mails, then use a spray can. A slogan on a bridge greets a lot of eyes. But whatever you do, do it now. The bomb may already be on its way. We'll continue to provide you with world-wide news coverage for as long as we can, but without your help that may not be—"

Richard flicked off the microphone in mid-sentence. Grinning through the glass at Med, he held up his hand and shook his head. He counted to ten, then turned the mike on again and said, "False alarm. But next time, who knows? Do something about it *today*, *amikoj*. Freedom of information, working for you twenty-five hours a day. We respect personal rights. We do not respect suppression."

Stepan Maksimovich slammed the telephone down angrily, but only after he heard the dial tone and knew it was safe to do so without angering Pyotr Igorovich. But *chort*, what news to swallow meekly. Eliminating the deepbombs! And all because of those Lunigans and their libertarian radio station. The insult was too much to bear. Even knowing the backup plan would still silence their seditious voice was hardly recompense for the damage they had done to Stepan's laboratory.

And what a stupid backup plan! Dropping a supply shuttle on them and then claiming an accident—who would believe such a transparent deception? It was an act of simple vengeance, one that would cause heads to roll when the

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final investigation came about. Expendable heads, surely—Pyotr Igorovich and Irina Borisovna were always ones to use such an event to clear the system of their political enemies—but how could Stepan know he was not intended for just such clearing now? Pyotr Igorovich had been all honey and consolation on the telephone, but he had cut the deepbomb program just the same. Why not cut the director of that program as well?

Stepan Maksimovich was no newcomer to Soviet politics. He knew the only way to avoid the axe was to direct the blow onward to someone else. He considered his enemies. Who among them could he pin the blame upon for the deepbomb debacle, and how could he link them to the shuttle crash that would take out *MoonSong* once and for all?

The link was already there, in a sense. The shuttles had been how they had gotten the deepbombs into orbit without suspicion. While the Americans had laughed at the pitiful inefficiency of the Soviet shuttle, that "inefficiency" had hidden the extra mass of a deepbomb on each flight. Released in mid-journey, the bomb climbed on to higher orbit with its ion drive while the shuttle continued on to rendezvous with the Moon base. The deepbomb launch was completely automatic; even the shuttle's controllers knew nothing about it.

The shuttle's controllers. Ah, yes. Now if one of them were to be found with incriminating evidence upon him. . . .

And if that controller happened to be Aleksey Lvovich Yevshenko . . .

Stepan smiled. Larisa might be implicated, but if he was careful, if he pulled the right strings, he could save her from banishment. She would know who had saved her, of course, and by then she would have no recourse but to marry him.

He wouldn't tell her what he planned, would probably not tell her even after. She was too fond of Aleksey, and too innocent of political machinations, to appreciate the subtle beauty of it. But he would have to tell her about the deepbombs. And, he supposed, to console her he would have to tell her about the backup plan to destroy the radio station. Very well. He would tell her that much. But he would mention nothing about Aleksey.

Ingrid stuck her head into Jason's office. "New rumors from the mill, honch. Looks like the deepbomb threat is out. Too much publicity, both before and after the fact." She grinned briefly, but it faded too fast. "Instead, word is the Sovs plan to stage an accident in their lunar base project and drop a shuttle on us. They figure they can use it as a Trojan horse to get close; we won't have time for the laser and we can't preempt it 'cause it's part of their normal base operations."

"How reliable is that information?" asked Jason.

"Pretty reliable. It's from our deepbomb source."

"How do they think they'll get away with it? The responsibility will rest entirely on their shoulders, won't it?"

"They'll almost certainly pull the Americans-in-the-Persian-Gulf defense on us. It will be a 'regrettable accident, so sorry,' but somehow they'll blame it on us. And the rest of the world is

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still pissed enough at us to accept their explanation."

"I guess we should be flattered they're willing to waste a perfectly good shuttle on us."

"Well, if I know the Sovs, it's a twofer special. They'll use it as an excuse to can some people in their lunar operations, too."

"I detect Suslov's hand in this."

"Prob'ly so, honch, Suslov and Orlova both, but our hard data doesn't run that far. Yet, anyway."

Suslov was Pyotr Igorovich Suslov, Politburo member, and Orlova was Irina Borisovna Orlova, also of that ruling body. They had both been against the Soviet lunar base since its inception.

Jason dabbled at his desk top absently with his stylus. Screens, menus, indexes lit briefly and died again as he triggered them, but he wasn't finding what he wanted. "Is that freighter module crewed?" he asked Ingrid.

"No, honch. Completely robot," she replied. She came on into the room and, leaning over Jason's shoulder, tapped the menu pad until a picture of a Soviet OTV came up on the screen. It was a typical piece of Soviet technology: a framework of booms and attachment points jutting helter-skelter, like a spider on LSD. Ugly, no-frills, clunky, but rugged and reliable. The Sovs had long ago learned hi-tech was not necessarily synonymous with efficient, cheap, or practical.

Ingrid nodded toward the image. "It's mostly ballistic; give it a shove to start and a shove to stop." She pointed. "It's got standard solid-fuel modules for landin'. Other than that, just little H_2O_2 thrusters for course corrections."

"How do they guide it?"

"There's a navigation broadcast from their lunar base. It uses that as a beacon. They'd have to have some sophisticated software on board, though, to optimize thrustin'. If you just tried to home on a beacon d'rectly you'd be out of fuel in no time."

"So what'd be the easiest way to sabotage such a thing so it hits us . . . ?" Jason thought a moment, then said, "Set it to home on *our* transmission, right? We broadcast all the time. It gives them a dandy signal."

Ingrid was way ahead of him. She reached over to the desk again, tapping her finger on a menu displayed below the graphic of the OTV. Suddenly a table of specifications on the OTV's guidance computer occupied the screen. Question marks filled some slots in the table, showing where data were still unknown despite *MoonSong's* network of sources.

Ingrid was a computer hacker by nature. She looked at the table for a minute, then said, "The basic guidance software's in an EPROM, but there's gotta be a RAM part, too. They need to update the flight plans. They don't always start in the same relative position, so they'd need new constants for their equations.

"And," she tapped at the desk again, got a blank screen, then brought the last one back. "No data on it, but that RAM must be updatable by comm laser. They don't want to have to rendezvous just to update! Much cheaper to zap in an update from afar. To put in our frequency, then, I'll bet you they just patch in a kluge to bypass the EPROM."

"I bet the OTV has a self-destruct,

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too, for emergencies," Jason commented. "They wouldn't risk dropping one on their base if the braking rockets failed. Could we trigger it? It's got to be just a pulse signal!"

" 'Just' a pulse, honch." Ingrid snorted. "A pulse *that* critical is goin' to be verified six ways from Sunday. It'll have a highly complex recognition code, probably changin' in some preprogrammed but random pattern. Anyway, that'd be a bail-out option; even if we blow it we'll still end up with a lot of debris on the trajectory, and some'll still impact."

Jason grinned a sardonic grin. "Once again the violent solution is out. OK, then, can we do something a little more *subtle*?"

Ingrid looked thoughtful. "Maybe, but for once the Sovs are playin' it subtle, too. They can claim their 'bot glommed onto our signal because we screwed up. Unauthorized power level, or frequency, or whatever, and so we drew it down on ourselves. Even if we survive, they could tie it up in the World Court for years."

Jason nodded. "That's exactly what they'll do. We can't even shout about it beforehand. Those are perfectly legit spacecraft. They'll probably decide which one to use at the last minute. They could make us look *real* silly crying wolf just by holding off for awhile."

"Of course," Ingrid continued, "the recognition code for updatin' the flight plan must be a lot simpler, and may even be standard. You need to be able to access it at arbitrary times by different personnel in different places. We have a tunable laser, too."

Jason saw what Ingrid was driving at. "You think you could reprogram their navigation computer from here?"

"Prob'ly, honch, if we could get hold of some recognition codes. They're likely to be standardized. But random trial's prob'ly out. Multiple access attempts with the *wrong* recognition codes will be sure to make the software notice. It would prob'ly file an alert."

"Could we realistically get the codes? In time?"

"There's a good chance, from one of our deepthroats in particular."

Jason thought a moment. "OK, I guess it's our best shot. But, Ingrid . . ." he paused. "Let's prepare to evacuate, just in case, too."

Larisa sweated despite the cool night air. Now was the moment when her marriage, indeed her whole life, would either come together beautifully or fall apart around her. She watched Aleksey watching her, standing there on the river bank, the shock still written all over his face, and she thought if he waited an instant longer to tell her how he felt, she would die of the suspense.

"Let me be sure I understand," he said quietly. "You want me to get you the control program for the shuttles. You want it so you can give it to *MoonSong*."

"Yes," said Larisa.

"*You*, the pride of the design laboratory?"

"Yes," she said again.

"The woman who smashed my radio."

"Yes."

Aleksey shook his head, but he was smiling now. "I never would have believed it."

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"Good. That means my cover is still believable."

"How long . . . ?"

"Years. Before we met. Before there was a *MoonSong*, even. I work for freedom wherever I can."

Aleksey stooped and picked up a rock, skipped it across the river, and took Lara's hand. They began walking slowly along the bank again. So this is why she had suddenly wanted to take a walk in the woods! Her orders had probably come in only hours ago. Or were they orders? "Do they ask these things of you, or do they demand them?" he asked.

"They ask, Alyosha. They are in trouble." Larisa detailed the plot against the radio station for him, telling him first about the deepbombs, then about the shuttle plan.

Aleksey nodded as she told him, but his next question came out of nowhere. "What about Stepan Maksimovich," he said. "Is he in on this?"

"No."

"But you do get information from him?"

Larisa knew what the implied question was. She couldn't look her husband in the eye, but she did manage to say, "Yes."

"I see. How do you communicate with *MoonSong?*"

"They gave me a pulse maser. I record messages and send them in a burst. When they need to tell me something, someone meets me on the street. I never know who it is."

Aleksey stopped walking. He turned and looked Larisa directly in the eyes, saying, "I will give them the control program. But I want something from them in return."

"What do you want?"

"I will not tell you. Give me your pulse maser. Show me how it works. I will send them the program and make my request directly."

Ingrid scanned the message with eyebrows raised. There was the control program in its entirety, along with a backup for redundancy. Aleksey had done well. But what was this request for a program in return? And what a peculiar program it was to be! What he wanted was a sort of pirate, a specialized kind of virus program designed to bust into a protected data bank, get information, and get back out clean. Except it was a pirate that would *wipe* certain information if it existed, information leading to him, and in addition *leave* a trail intentionally leading anyone who looked for it from the shuttle communications computer directly to the design laboratory where Larisa worked. Not to Larisa directly, but to—

Suddenly, remembering Larisa's "report" on the deepbomb threat, Ingrid laughed out loud. So Aleksey knew about Larisa and the Director, and in typical Russian style, he had come up with a way to solve the problem once and for all, saving his own skin and without losing his wife in the process. Ingrid laughed again, and smiled all the while that she wrote the program for him.

Aleksey stepped off the bus, automatically pulling his collar up against the cold. He began walking toward the space communications center, but a sud-

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den blow to his back sent him sprawling.

"*Izvinitye, tovarishch!*" a voice said. Aleksey saw a man standing over him with hand extended to help him up. "My fault entirely. I wasn't watching where I was going." The man helped him to his feet, brushed the dirt off his coat, and apologized half a dozen more times. After gaining Aleksey's assurance he was all right, the man turned and disappeared into the crowd, leaving Aleksey standing there beside the departing bus.

Belatedly, Aleksey's hand went to his wallet, and he was relieved to find it still there, still in his pocket. But there was something else there with it! He turned and began walking, but not until he had turned the corner did he reach into the pocket and feel the contours of what his assailant had left him. A computer diskette. Aleksey smiled in satisfaction and looked up to the sky, but the Moon was nowhere in evidence. *Of course not,* he thought.

Ingrid watched the CRT nervously despite her professed confidence. The strain was getting to her. She had downloaded the guidance software from half a dozen OTVs in the last three weeks. Every time the software had responded to the recognition codes and had allowed access. And every time it was clean. So far the Sovs seemed to have no inkling each craft was being interrogated, but so far there'd also been no hint of sabotage.

This was the seventh OTV. It responded, just like the others, and within a few milliseconds its software guts were also spilled into Ingrid's computer. Automatically she backed it up and started the analysis program, comparing against the copy Aleksey had sent her. Theoretically it should be easy to pin down any place that had been patched, but after three weeks and still no bogey, she was beginning to get nervous. If she missed the crucial one—

A beep from the terminal startled her. "Bingo . . ." she muttered. Maybe. She scanned the anomalous code the analysis program had found and displayed. It was already disassembled; the analyzer evaluated alternative interpretations and chose the most reasonable.

"Bingo!" she said again. On her screen stood *The Daily Planet's* frequency. The analyzer had recognized those fields as data, and had interpreted them accordingly. She buzzed for Jason. "Think we've got the Trojan, honch."

"On my way over, Ingrid."

He arrived within seconds, Richard in tow, and came over to look at the screen. "That's it, huh?"

Ingrid wasn't listening. "Just clobber the patch . . ." she muttered. "Just clobber the patch. Well, let's see if uploads work, too." She rechecked her code again, then punched a key, almost convulsively.

Then she waited a few seconds, and downloaded back again from the OTV. A quick compare, then . . .

She breathed again. "Clean code, honch. We did it, this time."

Richard was grinning like a thief. "It looks so easy."

"It *wasn't* easy!" Ingrid retorted, but before she could elaborate, the commercial comm link chimed. Jason and Ingrid both jerked as if their fingers had

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been in the ringer circuit. Who would be calling them now?

Jason reached over and touched the receiver.

Pavel Petrovich Polchinskiy, commander of the Russian lunar base, looked out at them. A stocky man, fiftyish, in a Strategic Rocket Forces uniform, he said without preamble, *"Saluton, Sinjoro Thomas.* I am sorry to bother you, but we seem to have a glitch with one of our freighter OTVs. It is trying to home on your transmission instead of our beacon, and our diagnostic program warns us its braking rockets may fail as well. We are trying to recover control, but we must alert you that you may need to evacuate."

"Gee, Colonel, we've been monitoring that shuttle, too, and our instruments show it's on course." Jason said innocently.

Polchinskiy looked momentarily nonplussed, but recovered with commendable rapidity. "Ah . . . Well, I'll check our data again."

It took a good three minutes for Polchinskiy to return. When he did, he wore a rigid poker face. "You seem to be correct, *Sinjoro.* Hopefully there is no problem. But we felt obligated to relay a warning."

"And we thank you Colonel. Please keep us posted on things." A gratuitous suggestion, that. *"Spasibo i vsevo khoroshevo."*

"Vsevo khoroshevo."

Polchinskiy's image faded, and Jason let out a whoop of laughter. "What a story!" he chortled. " 'The wonders of socialist technology.' 'Errant lunar freighter fixed free of charge by a private enterprise.' Boy, we can run it into the ground. I *love* embarrassing the Soviet Union!"

"We can't do that, Jason!" Richard said, appalled. "If we tell that story, a lot of Soviet sources will get shot. They'll *have* to figure someone leaked something to us, and it wouldn't take them long to figure out where the leak was."

They'll find the leak, all right, Ingrid thought. Or at least *a* leak. But Richard was right; if they gave it too much publicity, the whole spy network would be under investigation. More heads than Stepan Maksimovich's, and his cronies in the Politburo, would roll.

"As it is, they don't know what happened," Richard went on. "Maybe their 'sabotage' screwed up, or maybe we undid it—but if we undid it, what did we do? And when? And did we have help? They *don't know!"* Richard was almost desperate. Jason's clumsy broadcasts were one thing, but this was betraying sources!

"That's right, honch," Ingrid chimed in. "Those people on the ground rely on us to use discretion. That's in our interests, too, otherwise we won't have any sources. And besides, if this leads to an internal shakeup our deep throats will be better placed. The political situation in the Politburo was on a knife edge. This fiasco could tip the balance."

"We do not suppress information!" Jason practically shouted. "Secrets are the weapons of governments!"

"So *we're* going to trample on people who've trusted us, just to embarrass a government? That's not moral, Jason!" Ingrid used his first name only when she was upset. "How are we any better than a government, then?"

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Jason opened his mouth to retort, but closed it again before he said whatever he'd intended to. "Compromises," he muttered. "First a little lie to protect our sources. Then a bigger lie to protect us. Then . . . where will it end?"

"It ends wherever we take it," Richard said. "But this time *I'm* writing the story."

Director Larisa Ilinichna Yevshenko stared sardonically at the portrait of Lenin across her office. "*Vot ya, Vladimir Il'yich* . . ." She thought it ironic she and Lenin had the same patronymic.

Lenin said nothing.

Larisa shook her head. She still hadn't gotten over the promotion. Rumor had it Stepan Maksimovich had been bundled off to Novaya Zemlya—on *very* short notice. She smiled wryly to herself. It probably had something to do with his friends in the Politburo — *formerly* in the Politburo. The irony was even greater because Larisa knew that to have gotten this position she must have had both good marks for competence from the previous director, *and* a clean bill of health politically.

She remembered with a shudder how her heart had thudded when she saw the dark-suited man waiting at her office yesterday morning. *That* had been close; real KGB would have noted her fear. But her luck had held; he was an academician—undoubtedly with a KGB commission, to be sure, but not a professional—with ritual congratulations on her advancement. She had managed not to collapse with relief.

Aleksey's reaction had been almost as rigidly controlled. He had made it home before her, and was already cooking dinner when she arrived with the news. "Good," he had said simply, but then he had smiled and kissed her and showed her the table already set for dinner, a dinner of black market beef and vegetables and a bottle of French wine.

"A hunch," was all he would say when she asked him how he had known.

A hunch. Well, Larisa had a hunch life with Aleksey would be a little more fun now than it had been, secrets or no.

Richard Salas was reading copy into the microphone. He hated reading copy, but this was the first time he had broken his own story, and he wanted to get it right. Trying to make it at least *sound* ad-lib, he said:

"And now for a bit of local news. Our neighbors here at the Soviet base gave us a scare a couple days ago when they called to tell us one of their supply shuttles had mistaken our radio transmission for their beacon. An understandable mistake, wouldn't you say? It turned out to be a false alarm, but all of us here at *MoonSong* want to thank the Soviet Union for giving us such a prompt warning, anyway.

"In an unrelated story, the Soviet Union announced today the retirement of Pyotr Igorovich Suslov and Irina Borisovna Orlova from the Politburo, citing health reasons. They announced the appointment of Viktor Viktorovich Malenkiy and Yuro Vasileyvich Grechko to replace them. Analysts are divided on the reasons for the changeover, but speculate that . . ."

In his office, Jason Thomas grimaced and shook his head. Softly, he whispered, "We respect personal rights; we do not respect suppression. So which is it, *amikoj?*" ■

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futures

Matthew J. Costello

A few years ago I was talking to the president of a game company and mentioned a comic book that I thought had incredible potential—as a role-playing game, boardgame, or just about any kind of licensed product.

"It's called Teenage Mutant Ninja Turtles," I said. But he shook his head and said that he didn't think the Turtles had "any legs." (That's showbiz lingo for a product's or concept's ability to linger in the marketplace.)

Hoo-boy, have I had fun reminding him a half-dozen times or so about my suggestion. Because The Teenage Mutant Ninja Turtles, created by the team of Eastman and Laird, continues to be an incredible, almost improbable phenomenon, with figures, and toys, and games, and cartoon shows—all based on some irradiated turtles trained in the martial arts. It had lots and lots of legs. . . .

My investment in the project, though, remains my mint copy of TMNT—worth over $175.00 the last time I checked "Overstreet's Comic Book Price," the bible of the comic book investor.

One of my favorite comic books, *Mr. Monster*, was affected by the popularity of the Turtles. *Mr. Monster*, aka Doc Stearn, is the brainchild of Michael T. Gilbert. A costumed hero devoted to persuing the monsters of the world, Gilbert's creation is actually a hip updating of a none-too-successful series from 1947.

"I uncovered the original Mr. Monster in 1971," Mike told me. "He appeared in a couple of early issues of Super Duper Comics." The attraction of this odd hero was immediate. "I thought it would be really fun to redesign the most obscure superhero ever."

The new Mr. Monster first appeared in Pacific Comics's anthology collection, Vanguard Illustrated, and then, when Pacific folded, Eclipse Comics picked up Doc Stearn for its own books. Aided by his assistant, the curvaceous Kelly, the pipe-smoking Mr. Monster was unflappable facing everything from ghouls to the disturbing Hemo Boy. Alan Moore, writer of Swamp Thing, guest-scripted a Mr. Monster story and there were plans for a Mr. Monster/Swamp Thing team-up.

But then, disaster.

"What really hurt it was the big black and white explosion of bad teenage mutant ninja turtles. The dealers were getting "hot" books at the expense of what were actually good books. And Mr. Monster and a number of really good books were hurt."

Both Gilbert and Eclipse agreed that the color series should end. And that's when I thought Mr. Monster vanished.

But Gilbert was also interested in finding a new home for his creation. He was moving to Oregon and, by happenstance, a new publisher, Mike Richardson's Dark Horse Comics (2008 S.E. Monroe St., Milwaukie, OR 97222) was an admirer of Mike's creation.

A new series, volume two, was

(continued on page 111)

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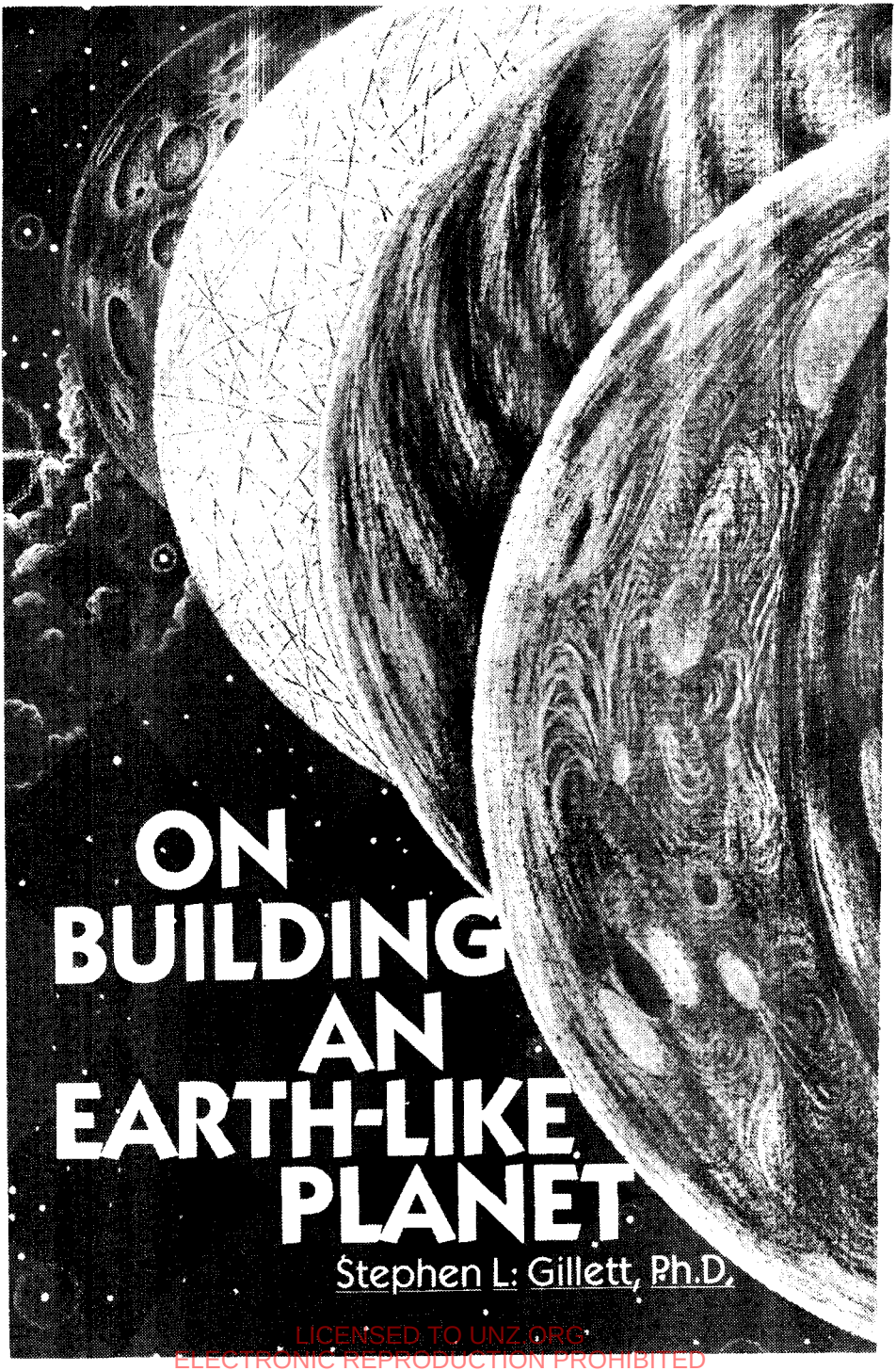

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World-building is an essential skill for a science fiction writer—and, like any other such skill, needs periodic updating.

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World-building is an old SF standby—remember the best of Hal Clement, or Poul Anderson, or any of a dozen others. Anderson (1974, 1976) even wrote a couple of essays for SF writers on how to calculate surface gravity, average illumination, and other such nitty-gritty. Elsewhere, I've contributed some speculations on possible planets in general (Gillett, 1984), which try to update things with the flood of knowledge in the last 20 years. (I've fretted for years that the planetary science in much of SF is so *dated.)*

But what about "habitable" planets? It takes more than just the right distance from the Sun, the right size, the right star, etc., to make a planet Earth-like! What other constraints are there? (And—the fun part!—what variations might there be?) The revolution in Earth science over the last generation has given us a much better idea of what makes an Earth an Earth. It's surprising some of the subtle constraints that get missed by SF writers. So I'll try to explore what makes up "habitability" —construed to mean "Earth-like"—in the light of current knowledge.

THE PLANETS EARTH

First, whaddya mean by "Earth-like," anyway? The Earth has been very different at different times in the past, and some of the Earths of the geologic past are as bizarre as anything in fiction. So, we can use the ancient Earth as a model for some variations; and we'll have to remember that any other real planet will vary over geologic time, too.

Everyone's heard of the Ice Age—"Ages," actually. The glaciers have chugged down from the pole several times in the geologically recent past, and it's now pretty much the conventional wisdom that the *recent* waxing and waning of the ice correlates with small, periodic variations in the Earth's orbit and axial tilt—the Milankovich variations. (Milankovich was the Yugoslav astronomer who proposed this theory back in the '40s.)

But in a real sense we're *still* in the ice age; there are massive ice caps at or near both poles. All that happens during the cold part of the Milankovich cycle is the caps get bigger. But during much of Earth's history it appears there has been no polar ice at all. Continental configurations change as shifting plate motions shove the continents around like scum on a pond. (Plate motions go *way* back: Pangea didn't just suddenly decide to fragment in the Jurassic! It was only the latest aggregation in a long history.) And presumably, when the continents are positioned so that seawater circulates freely between the tropics and the poles, climate is much more equable over the globe. (This state of affairs is probably also abetted by the "marine transgressions" described below.) To be sure, other effects also could set up ice age conditions, such as variation in insolation if the Sun sputtered, but the disposition of land and sea is always a major effect. ("Insolation" is the amount of sunlight a planet receives.)

Ice ages nonetheless happen fairly frequently; the oldest documented glacial features are about 2.5 billion years old, and major glaciations happened in the late Precambrian (about 700-800

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million years before present), Ordovician (about 500 MYBP), and the late Paleozoic (about 250 MYBP). They also have side effects that are not always appreciated, such as a profound effect on oceanic circulation (of which more anon).

If a glaciation were ever so severe that the Earth froze over completely, the resulting ice ball would probably be stable. Its albedo (reflectivity) would be increased by so much that it would never melt, unless some outside mechanism caused better trapping of solar heat. (It's now thought that, on an active planet like the Earth, CO_2 exhaled from volcanoes will eventually boost the greenhouse effect enough to melt the glaciers. The "greenhouse effect," of course, is now trendy; it's the tendency of certain atmospheric gases to trap heat, so that a planet cools off less efficiently.) On a smaller, less active planet, though, such a "runaway glaciation" remains a possible disaster for Earth-like worlds. (The ice-covered Jovian moon Europa is a small-scale analog.)

SPECULATION WARNING: The evidence is shaky, but there is some indication (from paleomagnetism, see Embleton & Williams, 1986) that the late Precambrian glaciation involved very low latitudes. Assuming these data are correct, the simplest inference is that glaciation once *almost* went to completion. However, there's another possibility. If the Earth's axial tilt had been much larger (for some reason), some models suggest the equatorial regions are better places to grow glaciers than the poles. The poles have six-month winters, to be sure, but they're followed by six-month summers, and it's hard to preserve any snowfall. By contrast, the "tropics" are milder year-round, and maybe they could accumulate snow onto glaciers. If this were true, we would expect to find *no* glacial deposits at contemporaneous high latitudes, but so far the data aren't nearly good enough to show that.

Back to oceans. Ofttimes our (misnamed) Earth becomes largely Sea, during those "marine transgressions" I talked about. Indeed, the continents presently stand unusually high above the sea (or sea level is unusually low, depending on your point of view). Commonly, shallow, "epeiric" seas cover much of the continents. Such marine transgressions probably occur when seafloor spreading is more active than at present; the ocean floor bulges and spills water onto the continents.

Even so, the continents are not standing as high as they were before most of the glaciers melted. This melting, about 12,000 years ago, raised sea level by about 100 meters, and the rise had profound effects on coastal environments. Look at almost any stretch of seacoast in the world. What we naively think of as a "typical" shoreline, intricate with inlets, estuaries, bays, and fjords, and festooned with bars, spits, and offshore islands, is in fact an ephemeral product of the flooding by the Holocene sea level rise. The shoreline is being smoothed out rapidly; estuaries, for example, are drowned river mouths, which are being filled from behind by sediment brought down by the river, and which are also being walled off from the open sea by bars and spits, products of long-

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shore currents. Maintaining a convoluted shoreline requires a rapidly varying sea level.

Other past differences stem from evolutionary innovations by living things. Of course, we've all heard of oxygen itself, and the profound changes it wreaked when plants began to dump it into the atmosphere in large quantities. But life's effects run much deeper than that. In fact, it's becoming obvious life is much more intimately involved with many geologic processes than we'd thought.

One modest example: As I discuss below, various critters build shells with calcium carbonate, and before about 70 MYBP major shell-building was confined to shallow tropical water—reefs and such. However, a major group of protozoans, the Foraminifera, now make tiny shells—"tests"—in surface water in the open sea. When they die, their tests sink, and if they don't completely dissolve in the deep cold water, carbonate accumulates on the deep sea floor. Such "pelagic limestones" are new in the geologic record, and one of their effects is that a lot more limestone is going to chug down subduction zones as plate tectonics continues. A shift in volcanic styles may be one result, as CO_2 becomes a more important component in the mantle.

Another example is the rapid colonization of the continents by land plants, which exploded onto the land in late Silurian and early Devonian time (pre ca. 400 MYBP). It's now extremely hard to visualize a pre-Devonian landscape in a humid climate. We're so conditioned to jungles it's not at all clear what the land looks like if there's *nothing* to grow, no matter how much rain. Yet there were just microbes on Earth for almost 4 billion years; and for at least the last billion years of that time the O_2 atmosphere was already in place. How come so few SF stories describe such worlds? On an alien Earthlike world, explorers always seem to be hacking through jungles, rather than tramping across barren lands. If there *are* other Earthlike worlds, most will still be in the state of microbes-only, with scummy seas and empty continents.

Anyway, if you would construct an alien world, look first at the ancient Earth. So, I won't use the Earth as a point of departure. I'll use the Earths! And from the above, you can see there are subtle interactions between the many parameters that make up "habitable." Although this article is condemned to a doggedly linear presentation of possibilities, just by the constraint of language, remember you can't, say, just dissect out the "atmosphere" without worrying about the insolation, the temperature, the tectonic processes, crustal reactions, etc., etc. . . . Planets are complicated!

DO WE NEED THE MOON?

The Moon probably doesn't affect geology or climatology greatly. Tidal effects occur, to be sure, and there's some meager evidence earthquakes may correlate with the position of the Moon, but any effect is weak. You *don't* need tides to release stress in the Earth; rocks fail just fine without it, thank you.

Despite Isaac Asimov, the tides are

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probably grossly overrated as an evolutionary driver, too. . . . not only do we still have the solar tide even without a moon, but influxes of water far up on the shoreline from major storms will occur in any case. (In fact, sedimentologists even speak of "storm tides.") Evidence of such deposition is abundant in the rock record, and the pools formed therefrom are likely to be much more important for evolution because they last longer than half a day.

Another thing you *don't* need a large moon for is "stripping away excess atmosphere." That's A.G.W. Cameron's long outdated idea, before there was a good understanding of volatile budgets on the terrestrial planets. But it still keeps showing up in SF stories. ("Volatiles"—a word we'll use a lot—are the low melting point, low boiling point stuff that makes up atmospheres and oceans.)

So what good *is* the Moon? Where it *may* have helped is by stabilizing the Earth's orbit. As was shown by Ward (1974), for example, Mars goes through major, periodic perturbations of its inclination and eccentricity. The Earth seems to be much less susceptible to such changes because, together, the Earth-Moon system has *much* more angular momentum than a solitary planet. Thus it's much harder to change the orbital elements of the center of mass of the Earth-Moon system. Hence maybe the Moon is an angular momentum bank. (Although if equatorial glaciations really indicate high axial tilts this obviously can't be true! So maybe the Moon is just a purty light in the sky, after all.)

Another note about moons, even just for decoration: Be careful about strewing them higgledy-piggledy around your planet. Resonances and tides strongly limit their numbers, orbital periods, and lifetimes! For example, suppose you had two satellites, one with a period exactly twice that of the other. Then, for every two revolutions of the inner satellite, the outer satellite would be in exactly the same place, tugging in exactly the same direction. The orbit is thus subjected to a consistent distorting force, and before long the two satellites will *not* have periods in an exact 1: 2 ratio. That's resonance, and it keeps orbiting bodies from having periods that are small integer multiples of one another.

As for tidal effects—well, a tide causes the affected body (e.g., a planet) to bulge symmetrically, toward and away (in fact, a tide is due to nothing more than the *difference* in gravitational attraction across an object). But such a bulge can be a handle whereby a third body (the Sun, say) can exert a torque with *its* gravity. Over time, one of the things that can happen is that a rotation of the tidal bulge, caused by the Sun's tidal torque, can in turn exert a tug on a satellite, causing its orbit to decay over geologic time. For this reason, satellites of Mercury and Venus are not stable, and sure enough, they don't have any. Around cooler suns than the Sun, where a habitable planet needs to be closer in, it may not be able to have a satellite.

ON BEING THE RIGHT SIZE

SF writers delight in making up a planet with nice numerical parameters

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in some fictitious guidebook ("surface gravity 0.84 standard, year length 382.63 Standard days, rotation period 31.22 hours . . ."), but, realistically, what sort of constraints are there on major parameters?

One fundamental point: A blob of matter the mass of a planet has the shear strength of water. So don't write about non-spherical planets, unless the non-sphericity is maintained *dynamically* (as with an equatorial bulge from the planet's rotation). Sorry, but Larry Niven's prolate spheroid Jinx, with the ends sticking out of the atmosphere, is just impossible; you might as well try building a house out of tapioca. One of James Blish's Cities in Flight novels *(Earthman Come Home)* had a similar flaw; the crust of the planet He was supposed to be stabilized by a giant iron latticework that bled off the planet's core. Cooked spaghetti would work as well as iron. The reason for the weakness of matter in bulk is the same square-cube law found by Galileo; strength goes up as the square of the length, but mass as the cube. The legs of an ant the size of a human would collapse. And the giants of myth would need skeletons much stronger than bone if they had human proportions. And a planet . . . well, a planet collapses in on itself as much as it can, to form a sphere.

That aside, ev'body knows mass, insolation, etc., are important, but it seems they are even more critical than was thought. With mass, for example, it's not enough to have sufficient gravity just to hold down the air, the planet has to be of the right size to *buffer* the air. That is, to maintain its composition the air has to interact with the rock of the planet over time, as in the carbonate/silicate cycle (which I'll talk about soon). But for such interaction to take place, the planet must be large enough to have tectonic activity for an adequate amount of time to keep the crust stirred up. Too small, and the planet loses its internal heat; too fast, and it runs down too soon.

But too large also makes for problems. For one thing, if the planet has water in the same ratio of water to rock as the Earth, the seas'll be too deep for much land to occur. Square-cube law again; the area of the planet increases as the square of its radius, but the mass goes up as the cube of the radius. And as many people have commented, life could arise just fine on a water-only world, but intelligent life (or, at least, spacefaring life) doesn't seem likely.

The proper size also depends on distance, because of the greenhouse effect. Close to the Sun, and you want a smaller planet with a thinner atmosphere; it's harder to overheat. Farther away, you need a large planet with a thick atmosphere; otherwise everything freezes up. (In our own system, terraforming would be a *lot* easier if we could swap the places of Mars and Venus.)

And for that matter, insolation may also be more critical than people have thought. Some climate models suggest the Earth rattled between runaway greenhouse and runaway glaciation over its history, rather like the Perils of Pauline. (The "runaway" greenhouse occurs when the greenhouse effect becomes so strong the oceans boil; that's what happened to Venus. It "runs away"

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because water vapor is also a greenhouse gas, and above a certain point additional water evaporated from the surface makes the greenhouse yet *more* efficient so things get even hotter, so *more* water evaporates . . . etc.) Moreover, the habitable zone is a moving target. Over the course of geologic time the Sun burns hotter and hotter as it accumulates more helium—the "ash" of hydrogen fusion—in its core.

So, either the orbit of the planet has to be *just* right, or there are feedback mechanisms that fine-tune the greenhouse effect. Life, or perhaps an inorganic feedback loop, such as the carbonate/silicate cycle described below, may carry out the fine-tuning. (It's nice that habitable conditions may not have to meet *quite* so stringent requirements.)

What about axial tilt and the year length? Too much tilt may be a problem, but perhaps not an insuperable problem, as in Anderson's *The Man Who Counts*. Certainly if low-latitude glaciations on the Earth reflect a high axial tilt, it's not fatal; the Earth survived!

But maybe no tilt at all would also be a problem. For example, the water supply in temperate climes mostly comes from snowmelt. If there's no winter, there will be no snow. Or, if the year's too long, all the snow melts before season's end and you have a *real* drought. (An extra season comes between summer and fall: the "DRY"!) The glorious summers on Ursula LeGuin's planet Werel (in *City of Illusions),* which had a year 60-odd Earth years long, would get a mite thirsty. And again, we can't speak of "the" tilt of a planet's axis; it will vary, perhaps substantially, over geologic time!

As many authors have suggested, eccentricity of a planet's orbit could probably provide seasons in lieu of (or in addition to) axial tilt. There'd be a wrinkle with probably major implications for meteorology, though; the whole planet will have the same season at the same time! *That'd* be neat for the atmospheres scientists to model. . . .

Rotation rate is another variable. Too fast, well, too fast and the planet can't hold together, so the problem goes away. But too slow is a different story. A rapidly spinning planet is easy to keep at a reasonable temperature, but as the rotation rate gets slower and slower, the day side tends to broil and the night side to freeze. You need to exchange heat —which, on very slowly rotating planets, would lead to *ferocious* winds—or heat needs to be stored in the daytime, to be released at night. (Warm, saline oceans, like those I describe below, might work.) The ultimate slowness of rotation is once per revolution, so the Sun never rises and sets at all. Poul Anderson (in *The Trouble Twisters,* as I recall) proposed such a habitable world; but I think the winds between the day and night side would (literally) kill you.

Note also the rotation rate changes over the lifetime of a planet; generally it slows down, due to tidal effects. The Moon, as most *Analog* readers know, is slowly "despinning" the Earth. Mercury and Venus have spun almost to a stop due to tidal braking by the Sun. And that leads to a problem, pointed out years ago by Stephen Dole: As stars get less massive, they get *lots* dimmer, so

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you have to be proportionately closer to them to get the same illumination. But when you do so, you're much deeper, relatively speaking, in the star's gravity field than the Earth in the Sun's field, so that the tidal braking is much stronger. Dole thus concluded dim red dwarfs (M stars) are very *bad* prospects for habitable planets.

WHY IS THERE AIR?

Now let's look more deeply at the skin-deep phenomena, the atmosphere, the oceans, and the surface itself.

By the early '50s it was realized Earth's present atmosphere couldn't be "primordial"; that is, left over from the condensation of the nebula that formed the Solar System. This follows because the noble (or "inert") gases neon, argon, krypton, and xenon are so rare in the atmosphere. The Earth can easily hold neon in its atmosphere, and it's an abundant element, as heavy elements go; it's only a little rarer than oxygen. But like all the noble gases, it stands aloof from chemical compounds, and freezes only at low temperatures. It's now thought virtually all the neon, along with most other volatiles, were blown out of the inner Solar System by the T-Tauri wind at the very birth of the Sun. (The T-Tauri wind is an intense stellar wind—an outflow of atomic particles from a star—that occurs right when the nuclear fires ignite.) It's probably hard to get a world like Diomedes (again in Anderson's *The Man Who Counts),* where neon is a major atmospheric component. (But neon is *so* abundant it's worth a try!)

So the Earth's atmosphere is secondary. Traditionally, it's been ascribed to "outgassing"; gases in chemical combination in rocks were eventually spewed out of volcanoes after the Earth stewed a little bit. This isn't a silly idea; we see exactly this happening at modern volcanoes.

But another idea has become trendy recently, although it actually dates back to the late Harold Urey, the grand old man of Solar System chemistry: The atmosphere was brought in at the very last stage of planetary accretion in comet-like bodies containing ices and other volatile-rich material. These bodies formed the late heavy bombardment, which pocked the Moon and other inner planets with giant craters. They represented material condensed farther out in the solar nebula, where it was cooler, and only later were they perturbed into orbits that caused them to collide at high speed with the inner planets.

The attractive feature of this notion is it nicely accounts for the *total* lack of water on the Moon, one of the biggest inconveniences for lunar development. The Moon's gravity is too small to hold the volatiles that come splashing on in such a high velocity impact. (The much larger Earth, on the other hand, can.) If the atmosphere resulted from outgassing, surely there'd be *some* water left in lunar rocks here and there. But we have seen absolutely none.

The Earth's atmosphere also contains about 1% argon, another noble gas. Could *this* be a relic of the primordial nebula? No—this argon is a product of the Earth itself. It is almost entirely the isotope argon-40, which in the Solar System as a whole is the rarest of the

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three stable argon isotopes. The argon-40 is "radiogenic," one decay product of radioactive potassium-40, an important (I'll *get* to why!) isotope with a half-life of about 1.3 billion years. (Of course, the fact that we see so much argon-40 in the atmosphere tells us significant outgassing of the Earth has occurred! We just don't know what else may have come out with the argon.)

The Earth's complement of the heavy inert gas xenon also is partly radiogenic. About 25% is xenon-129, and much of *that* is from the decay of iodine-129. With a half-life of only 17 MY, iodine-129 is now totally extinct; but at the time of the Earth's formation a smidgen still existed to be incorporated in rocks. Since iodine is chemically reactive, it's much easier to accumulate than xenon.

Other xenon isotopes result from spontaneous fission, some from uranium, some from thorium, some from the extinct nuclide plutonium-244, with a half-life of about 80 million years. (Spontaneous fission is a decay mode in which the radioactive nucleus up'n'fissions all by itself.) Like iodine-129, some plutonium-244 was still around to get incorporated in the forming Earth. (Note this is a different isotope than plutonium-239, used in nuclear weapons, which has a half life of only about 25,000 years.) Most glamorously, spontaneous fission of the fabled superheavy elements may also have contributed to the xenon.

Helium is also a radiogenic gas; alpha particles from the radioactive decay of heavy elements are, of course, helium atoms. For every atom of uranium-238 that bites the dust, you get eight helium atoms. This is the source of the helium found in some natural gas wells; uranium and thorium often occur in sedimentary rocks, and the helium they produce gets trapped like any other natural gas. (In fact, one modestly trendy oil exploration technique is "helium sniffing": Since helium escapes its reservoir more easily than hydrocarbons, it can sometimes be detected at the surface.)

Unfortunately, once in the atmosphere helium doesn't stick around; it is so light that, like hydrogen, it eventually escapes to space. Its residence time in the Earth's atmosphere is only about a million years. (This fact was used in Niven and Pournelle's *The Mote in God's Eye*; since Mote Prime had about 1% helium in its atmosphere, the expedition scientists eventually inferred a long-lived technical culture, since the helium couldn't have remained over geologic time. Presumably the helium was the waste product from hydrogen fusion.)

PHOTODISSOCIATION: THE MONSTER THAT ATE AN OCEAN

Of course, once an atmosphere exists its composition will change as new processes act on it. One such process, whose importance was almost totally unrealized B.S. (before spaceflight), is photodissociation, the disruption of gas molecules by solar ultraviolet light at the outer edge of the atmosphere. It's most significant for hydrogen-bearing compounds such as water, because a planet with Earth's gravity (or even somewhat more) cannot keep hydrogen; too many molecules have escape veloc-

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ity, and they just keep going. So once you bust up a water molecule, chances are the hydrogen is lost forever.

On the Earth, the atmosphere gets cold enough to freeze out most water before it gets high enough to be destroyed—the so-called "cold trap." But without a cold trap, it's easy to destroy an ocean's worth of water in a fraction of geologic time; that's what happened to Venus. Water loss will especially be a problem on a planet with high UV flux; type F stars may also be bad bets for real estate.

(There's a nostalgic echo of Percival Lowell here; one of his almost forgotten notions was "desertification": Over time a planet inevitably loses its water to space. P.L.'s gotten a bad rap in recent years; his famous Martian canals turned out to be a product of illusion and wishful thinking, and his prediction of the orbit of Pluto is turning out to be a coincidence. It's nice he got *something* right!)

Another consequence of photodissociation is that the traditional "early reducing atmosphere" of ammonia (NH_3) and methane (CH_4) most probably never existed; these molecules are just broken up too easily by solar UV (Titan's nitrogen atmosphere comes from such photodissociation of ammonia.) Besides which, we see no evidence for such a reducing atmosphere in the geologic record. (Among other things, NH_3 reacts enthusiastically with water and we should see *some* indication of different marine chemistry. But we don't. See, for example, another article of mine (Gillett, 1985).) Alas, no primitive Earth-like but lifeless worlds, sterile oceans swathed with a reducing welkin, are awaiting biological seeding packages, as Larry Niven proposed in *World Out of Time*. (Sterile worlds dominated by thinnish CO_2 atmospheres might be a different story, however.) Another aside here: those traditional ammonia-instead-of-water worlds, such as Anderson's t'Kela in *Trader to the Stars*, are going to need an atmospheric cold trap to preserve their ammonia.

As I just hinted, other processes affecting atmospheric composition are reactions with the crust and ocean. One of the most important such processes is the carbonate-silicate cycle, or the "inorganic carbon" cycle. Everybody learned in kindergarten about the organic carbon cycle: Plants take up CO_2 and release O_2 using the energy of sunlight; then animals breathe the O_2 to oxidize food and re-release CO_2. But CO_2 also participates in an *inorganic* cycle, and—at least in terms of the quantities involved—this cycle is by far the more important.

In this cycle, CO_2 dissolves in water to give a mixture of carbonic acid, bicarbonate ion, and carbonate ion; the carbonate ion can then react with certain metal ions to precipitate carbonates. Usually the metal is calcium, and you get calcium carbonate, which occurs as the minerals calcite or aragonite. They make up limestone. Under certain conditions you can get a double carbonate of magnesium and calcium, dolomite, and under highly unusual conditions you can get other carbonates in certain alkaline lakes. But calcite making up limestone is the biggie. (It's not realized as widely as it should be that most of

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the Earth's CO_2 is in its crust. It's in carbonate, mostly in limestones. If you cooked out Earth's crust—say by putting the planet in a giant limekiln—you'd eventually end up with a thick CO_2 atmosphere like Venus's.)

The calcium in the calcite is derived eventually from silicate rocks. Solutions of CO_2 in water are mildly acidic—"carbonic acid"—and tend to leach metals such as calcium from rocks. They in turn consume carbonate from the solution, which forces more atmospheric CO_2 to dissolve. . . . Eventually you reach an equilibrium, with the atmospheric CO_2 pressure fixed by the carbonate concentration in the water.

Kasting, Toon, & Pollack (1988) have suggested that this carbonate/silicate cycle (*not* the biological carbon cycle) provides a long-term control on the CO_2 content of the atmosphere and so fine-tunes the greenhouse effect (see also Walker, 1977). They note as temperatures rise, CO_2 is removed more effectively from the atmosphere, whereas when they fall it tends to accumulate. Maybe Pauline wasn't in such peril after all. (The current CO_2 greenhouse effect from burning fossil fuels is highly temporary; it will be over in a few thousand years, as the carbonate reservoirs re-equilibrate.)

The carbonate cycle also guards against excess surface water acidity (this is why lakes in limestone country are virtually unaffected by acid rain). The soda-water seas of some SF stories are unlikely; you'd have to shield them from all calcium, and it's a *common* element. In the presence of rock and water, there's only so much carbon dioxide you can have in the atmosphere. (In retrospect, many of the old "wet Venus" models were naive for just this reason.)

The carbonate cycle is now mostly mediated biologically. Although it's easy to precipitate calcium carbonate inorganically, and much still gets precipitated that way, lots of critters have discovered that calcium carbonate makes a dandy skeleton; so they precipitate reefs, shells, needles, and a host of other forms. Most modern limestones are in fact accumulations of such debris, cemented with inorganically precipitated carbonate. Calcium carbonate also has the curious property, for a salt, of becoming *less* soluble in warm water. That's why things such as reefs and carbonate banks (e.g. the Bahamas) are concentrated in warm, shallow water; i.e., the tropics. (In fact, sedimentary limestone abundance is a standard way of inferring ancient climates.)

(Another digression: on the Earth there are rare igneous rocks, "carbonatites," that consist almost entirely of carbonates! They are "igneous limestones," if you will.)

Of course, CO_2 isn't the only atmospheric gas affected by the activities of living things. Everybody knows oxygen's a product of plants. But it's not so well known nitrogen's just as much a product of life (not to mention methane and a host of other trace gases). Without soil bacteria constantly cranking out nitrogen, it would all eventually end up as nitrates in the soil or sea. (In fact, the only atmospheric constituents *without* a biological role are the noble gases!)

Why, on Earth, is the relative con-

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centration of nitrogen to oxygen about 4:1, and the total pressure about one bar? Again, it seems to result from feedback loops, and not all are subtle or biological. One of the simplest is flammability; things *burn*. This puts a strong upper limit on oxygen abundance; Lovelock found at oxygen concentrations of 30% or more even wet vegetation burns enthusiastically. The high oxygen partial pressures in Anderson's planet Starkad (in *Ensign Flandry*) probably can't occur; things simply get too flammable. (Halogen compounds inhibit flames; if such high-pressure worlds exist, maybe the local flora has evolved fire retardants.)

(Some controversial evidence, from bubbles trapped in amber, suggests that Earth's atmosphere during the Cretaceous, 70+ MYBP, may have been enriched in oxygen. So far this is completely unconfirmed; for one thing, in 70 million years the oxygen in the bubbles should have reacted with the amber!)

WHY THE SEA IS SALT

It's hard not to talk about the ocean when talking about the atmosphere—as you've probably noticed!—but there are still a few things I haven't touched on.

First, why are there ocean basins to begin with? If you graph height with respect to sea level for the entire Earth, you will find most values fall around two preferred positions; the abyssal depths (about -3000 meters) and the average continental height (about 100 meters or so). The Earth's surface is strongly bimodal, and it demonstrates that the continents are not just random high spots but real features of the crust. It turns out continents ride high above the mean surface of the Earth for the same reason ships ride high above the water surface; they're buoyant. They're made of lighter rock, silicates richer in aluminum, sodium, calcium, potassium, and other elements. Such elements don't fit well into the dense iron-magnesium silicates of the mantle, and thus they've tended to get sweated out of the Earth over time. If you have a planet richer in such material, you'll get more, or bigger, continents. It may be just happenstance that the amount of water on the Earth just slightly overfills the basins between the continents; on the other hand, it may not be. Plate tectonics may tend to pile continental rock together only until it's a bit taller than sea level, at which point erosion becomes very effective at flattening the pile.

Oceanic circulation is a major driver of climate, and it turns out to be intimately related to ice ages. As I said, we're still in an "Ice Age" now, because large bodies of ice exist at each pole. And polar ice has drastic consequences for ocean circulation. Surface seawater at the poles cools down to almost freezing, and thus becomes denser. It sinks and flows back toward the equator in the depths. This flow is compensated by the tendency of warm equatorial, surface water to flow back toward the poles. Thus, the modern ocean is dominated by cold water (except in the vicinity of a volcanic vent . . . a trifling exception, areawise) below a thin warm surface layer, the deep sea is almost freezing. The modern ocean is also oxy-

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genated; cold water holds more gas in solution, so the deep ocean (again, with trifling exceptions) is oxygenated completely to the bottom. Thus oxygen-breathers can live on the sea floor to scavenge and burrow.

But what if there *is* no polar ice? Then what happens to that warm equatorial surface water? It sinks.

HUH?

Yeah. Tropical *surface* water is also denser than average seawater, although not so dense as icy polar water. Although it expands upon heating, it also becomes more saline because of evaporation—and the extra salinity is what makes it sink. Hence, a warm ocean can circulate by having dense, warm brine sink at the equator and flow poleward, with the return surface flow coming from pole back to equator. (We see a small scale modern analog of such circulation in the Mediterranean. The Med loses more water to evaporation than it receives from rivers draining to it, and the deficit is made up by surface water flowing in from the Atlantic. A deeper return flow of denser, warmer, saline water flows out thru the Strait of Gibraltar.)

Warm water holds much less O_2 in solution, so deep warm water rapidly becomes anoxic. Thus it supports no population of burrowers and scavengers on the sea floor; only anaerobic microbes can live under such conditions, and organic material does not oxidize, merely accumulating in undisturbed layers. . . . Such conditions, called "euxinic," account for the widespread occurrence of "black shales" in the geologic record: black, organic rich, thinly layered platy rocks—what the mud turned into. The Black Sea is a modern example of such a euxinic basin. The Bosporus is much too shallow to allow circulation with the Med, and the Black Sea obviously has no sinking glacier melt to drive its circulation otherwise. So only the top 100 meters or so of the Black Sea are oxygenated, and contain a normal marine fauna. Below this the water is anoxic and full of hydrogen sulfide, and the seafloor supports only a few anaerobic microbes.

What about ocean salinity? Why *is* the sea salt? Well, that depends on how much water versus how much salt you have, and also on how much salt gets sequestered from the ocean (generally by evaporation). The ratio of water to salt—which essentially is the ratio of water to chlorine—might vary a *lot*. The volatiles make up a very small proportion of a planet, and how much chlorine (say) you get is probably a crapshoot. Why should we care? Sea salinity can have major effects on climate, because the saltier the ocean, the less freely water evaporates from it—and among other things, this can tweak the greenhouse effect!

And while we're on evaporation . . . the factor affecting salinity is how much salt gets separated from the water, and how long it stays separated. And separation can result from evaporation. Great beds of rock salt—halite—occur throughout the world, where seawater was trapped and dried up. The biggest such "evaporites," as geologists call them, probably stem from a process we don't see happening today on a large

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scale; a so-called "deep evaporating basin." A basin becomes semi-isolated from the open sea, and water therein becomes concentrated enough by evaporation to start precipitating salt. But it never dries up completely, always remaining connected enough to get new seawater with new salt. You can build up *very* thick salt deposits that way. The Zechstein beds in Germany; the Permian Basin in west Texas; the Lou Ann Salt that underlies most of the Gulf Coast of North America; all these are thick and vast expanses of evaporites probably stemming from concentration in such an evaporating basin.

And it's possible sometimes enough salt has been removed from the sea to have major climatic effects. At the close of Permian time, for example, about 250 MYBP, major extinctions occurred, and a possible contributing cause may have been freshening of seawater.

(It's ironic the dry Mediterranean, now a staple of SF, may never have existed. Much of the evidence for a desiccated Med is thick salt deposits on its floor. But they may have been built up in the same way as the Zechstein or the Lou Ann; access to the Atlantic was restricted, but it was not closed off completely.)

POWERING A PLANET

Tectonics is the geologist's name for all processes that raise the land. Obviously this requires energy, and it comes from heat released by decay of natural long-lived radioactive elements, mainly potassium-40, thorium-232, uranium-235, and uranium-238. In fact, the Earth is a giant, inefficient heat engine, convecting excruciatingly slowly from its internal heat. (Yes, that's right, too: Earth's tectonic activity was greater in the distant past, before these elements had decayed so much. We see preserved lavas — komatiites—with compositions that could only liquefy at much higher temperatures than any contemporary lavas achieve.)

As I've mentioned, a habitable planet needs a certain amount of tectonics to keep the crust stirred up; partly to keep the atmosphere equilibrated, and partly so that valuable nutrient elements, such as phosphorus, don't all end up buried and useless.

So, a habitable planet has to start out with enough long-lived radioactives to power tectonics over geologic time. Otherwise evolution never has a chance. How likely is it that a planet is endowed with enough heat sources? We don't know; it *seems* Solar System element abundances are typical of cosmic abundances, but there might be significant variations. A habitable planet that's "run down," with flattened continents, shallow seas, and degenerating life forms is a real possibility. The Earth may look like that in a few billion years after its internal heat sources have decayed some more.

THE OCEANS AND THE PLATES

All *Analog* readers have heard of plate tectonics, the dominant style of Earthly tectonics: plates are formed at mid-ocean ridges, spread apart, and eventually dive back into the mantle at "subduction zones" generally marked by an oceanic trench. Meanwhile, the buoyant continents are passively rafted

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around on top. The plates slide over a weaker layer deeper in the mantle, the "asthenosphere," which is probably convecting.

In another one of those synergistic relations, it looks as though plate tectonics may require oceans. The relative weakness of the asthenosphere results from the presence of a bit of water in the rock. Were they dry they would be solid and much stronger. At high pressure H_2O is quite soluble in silicates, decreasing both their melting points and their viscosity. Both effects come about because water splits silicate polymer chains:

. . . .—Si—O—Si— . . . + H_2O = . . .—Si—OH + HO—Si— . . .

(Silicate melts, for example, are highly polymerized into—Si—O—Si—O— chains; the richer in silica, the more polymerization. That's why high-silica lavas like those at Mt. St. Helens are much more viscous—and thus much more explosive, because gases can't get out—than relatively silica-poor lavas like the basalts in Hawaii.)

In turn, although water is continually outgassed via volcanic processes, it is replenished by seawater carried down at subduction zones, so the asthenosphere stays lubricated.

This may also explain why Venus shows no plate tectonics. Thus, the drastic differences between Venus and Earth just result from the greater sunlight at Venus: if the water never condenses, you never get oceans, so the CO_2 stays in the atmosphere rather than forming carbonates; thus things become *really* hot so over geologic time the water vapor photodissociates. And if plate tectonics requires oceans to keep the asthenosphere lubricated . . . (I *told* you insolation was critical!)

STIRRING THE INGREDIENTS

There's two problems in concocting planetary compositions; (1) what's there to start with; and (2) how does it fractionate (i.e., separate chemically)? To look at the first first (I don't *always* do things backwards): "Cosmic" abundance may vary, both from vagaries of the supernovae that make heavy elements, and from other processes (novae, stellar winds, etc.) that may locally contribute to the interstellar medium.

But variation is most likely in the elements heavier than iron, whose nuclei *take* energy to make. Nuclei in the vicinity of iron are the most stable; it takes energy to break them up, and it takes energy to build them up. In fact, iron is common as heavy elements go.

So, I don't think metal-poor planets are likely; if you've got enough aluminum, magnesium, calcium, silicon, etc., to build a planet, you'll have iron, too. (Maybe no lead, gadolinium, gold, or uranium, but that's a different kettle of fish—important, to be sure, but different. The big problem *there* is likely to be the absence of uranium and thorium to drive tectonics.)

The important compositional variations come more from chemical fractionation. I've already mentioned the lack of neon on the Earth; although it's a common element, it just got blown out of the inner system early on. Even the solid elements have fractionated a lot; I mentioned the continents, which have been sweated out of the mantle.

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But even more basically: mix together a planet-sized bunch of silicate and metal and what happens? The metal sinks, the rock rises. And elements that prefer iron to silicate follow the iron. For example, nickel is a relatively common element, being right there in that abundance peak with iron, and it's a relatively common element in the Earth *as a whole*. But virtually all the Earth's nickel is sitting 6,000 kilometers below us, in the core, where it doesn't do us much good. So just good ol'chemistry is one way to deplete your planet's surface in some useful elements.

(By the way, one thing that happens when the metal sinks to form a core is that lots of gravitational energy gets released. It shows up as heat—and if the proto-planet wasn't molten before, it is afterward! It's also spinning faster, because of conservation of angular momentum, and people have speculated that that may be one way to make satellite(s). If the planet ends up spinning *too* fast, pieces fly off!)

(In case you were going to ask, uranium and thorium, although they are heavy elements, do *not* end up concentrated in Earth's iron core. Both elements have strong affinity for oxygen —uranium metal is a fire hazard—and hence end up in silicates rather than metal. In fact, they—along with potassium—tend to concentrate into the continents(!), because all three elements are among those that don't fit well into the compact iron-magnesium mantle silicates. But enough remain in the mantle to drive tectonics.)

The sunken metal accumulates into a core, which on Earth is molten in the outer part. (Because it doesn't transmit seismic shear waves.) And this blob of molten metal is somehow responsible for the Earth's magnetic field. There's *lots* of controversy over what powers the geodynamo, but it seems to require (1) a rapidly rotating planet; and (2) an electrically conducting core. Venus has probably got an iron core like the Earth's but rotates slowly; it has no field. Mars rotates at about the same rate as Earth, but probably has a small core or none at all; it also has no field.

That said, what good is the magnetic field? It's not clear. In fact, it's not at all obvious that most lifeforms need a magnetic field at all. Here's a good time to bury another notion in the popular literature; magnetic reversals are *not* correlated with extinctions. They're just too common and just not that big a deal. Moreover, the reversal itself lasts a few thousand years, and during that time Earth's main dipole field seems to vanish completely. There's still the nondipole components, amounting to several percent of the main field, so there's a *little* bit left. But not much. So actually, magnetic reversals select very strongly for *in*dependence of the planetary magnetic field.

PARTING SHOTS

Well, there's *lots* more, but Stan says the article's too long already. So I'll just leave you with this: Planets are complicated, and everything is hooked to everything else. ■

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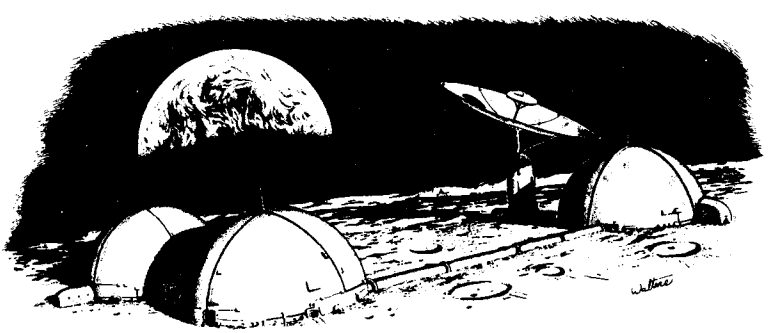

●Most of the critical things in life, which become the starting points of human destiny, are little things.

R. Smith

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The Alternate View

TECHNOLOGY AND ACADEMIA

G. Harry Stine

Judging from the mail I receive from readers of this feature, many of them are hard at work in the groves of academe involved in being educated so that they can aspire successfully to the Great American Dream: making a living without working.

Hold on! I used a semantically-loaded sentence just then. But it's nonetheless true. The American dream for more than 200 years has been to Make a Living Without Working.

The late Robert A. Heinlein once described writing as a way to make a living without working. I didn't catch the nuance of that until recently, when I realized that making a living without working wasn't just a goal for authors but was, in reality, a statement of the Great American Dream.

By "work" I mean the sort of dreary, exhausting, debilitating, physical labor involved in Plowing the South Forty or Digging Ditches, toil which causes you to come home after 8 or 10 or 12 hours, utterly exhausted, and unable to drag yourself to the PTA meeting or the Little League game or the final tournament of the bowling league. When you're working like that, you don't go to aerobics class or pump iron because you don't have enough energy left!

We and our forebears decided to work smarter, not harder. So we developed technology and built machinery and developed computers and did a lot of things that historically will separate this century from every century that preceded it.

And to ensure the achievement of this Great American Dream, our forebears also had the foresight to create great universities such as Harvard, William and Mary, and Yale as well as all the land grant colleges that grew from the Morrill Act. Americans have placed a premium on education as a way to learn how to make a living without actually working.

Ask any undergraduate why they're spending four years at any university, and not a single one of them will tell you that they're there to learn how to work. Ask any parent footing the bill for said undergraduate, and not a single one of them will tell you that they're sending their offspring to an institution of higher learning in order to learn how to work.

Building on the European tradition of scientific research carried out in the academic environment (which is where most of it had to be done before the Industrial Revolution), most universities require that graduate students undertake original research and write a report or thesis about it. Often, this research must dovetail with whatever studies the thesis advisor is working on under a grant. Much of this research is true scientific research—i.e., you don't know the answer ahead of time. Or you're out to prove a hypothesis by

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means of testing it in an elegant experiment.

But some colleges and universities have foisted on their hapless graduate students studies in applied research—i.e., technology.

Scientific research is quite different from technology development. Unhappily, far too many institutions of higher learning have gotten into technology development, and this is probably a mistake because their professors and graduate students can *never* manage to keep up with the state of the art out in the real world.

Why? Because new technology is usually discovered by an *inventor* and is perfected by *engineers,* produced by *technicians* and other artisans, then brought to users by *marketing people*. Later, *scientists* come along and try to explain why. (This is a generalization, or course, since a recent invention, the laser, was for many years a "solution looking for a problem." But, by and large, out in the real world, this is the way things get done and the way we've developed things to do away with having to work for a living.)

Let me again define my terms. Technology derives from the Greek root *tekhne* meaning "art" or "skill." Technology, therefore, is at its roots a skill or way of doing things. It requires know-how. It *is* know-how.

Most universities come up on the short end of things when they try to develop technology.

Let me give you a few examples from personal experience.

Between my junior and senior undergraduate years, I spent a summer working as an electronics technician at White Sands rocket proving ground in New Mexico; what I learned in a mere ten weeks was so far beyond what my physics professors were trying to teach me that I finally gave up and presented them with the answers I knew they wanted rather than answers based on the latest technology. My undergraduate thesis was on the subject of digital computers—the IBM Selective Sequence Electronic Calculator had just come on line with 12,500 vacuum tubes, 21,400 electromagnetic relays, punched paper tape for memory storage, and a capability to add or subtract a 19-digit number in 300 microseconds. I received the grade of C for my study paper investigating the utility of such computers in analyzing meteorological data because the professor thought that the application was far beyond the capability of such devices. At about that time, an IBM marketing study indicated only nine SSECs would serve all the computational needs of the entire world for decades to come; but we had several UNIVAC computers at White Sands and desperately needed more to keep up with the constant flow of wall-to-wall flight test data.

I recently visited a university computer lab; they were hard at work on computer graphics, developing programs that would take a three-view drawing and convert it into an image that had shading and would also move to show the interactions between the parts. They had a Cray to do this work. It was only a few months later that a friend showed me what could be done with an Amiga personal computer, and it made the university's work look childish. Most recently, my son bought a

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CAD program for his Macintosh; it does everything the university program would do and more.

In another university lab, I saw them working on a robotic arm that would be able to reach out and grasp an object, pick it up, and put it down somewhere else. When I went into Lionel Playworld a few months later to buy my granddaughter a present, Mattell had toy robots that did more and did it better.

I recently received a letter from a doctoral candidate in electrical engineering from a very fine midwestern university for which I have the greatest respect because I know many of the profs there—and they're good. The letter challenged my assertions in the December 1988 column that voice-actuated data systems today involve more economic than technical problems. Voice-actuated data systems are, the letter says, things that researchers put under the heading of long-term goals in their proposals to sponsors. The state of the art, according to the letter, hasn't yet progressed past the point where symbolic processing technology can handle more than simple tasks such as understanding limited command languages. The letter writer assured me that I'm entirely unaware of the digital processing that needs to be carried out to process pressure waves into symbolic information. In short, I'm told that this problem is *hard*. Why, it might even require an AT which is beyond most people's budgets! With an expensive hard disk card in it, to boot. Plus a dictionary of at least 100,000 words. Who, the letter asks, is going to be able or willing to afford this?

I'm not a wealthy man. In August 1988, I bought a 286-based AT clone with a hard disk card. Radio Shack had them on sale, clearing them out to make room for their newer computers. I wrote something about this in my last column. Their newer computers, which sell for about the same price, have a voice digitizer. The word processing program I'm now using has a 60,000-word dictionary for spelling purposes plus a 40,000 word thesaurus. (It just told me right now that I'd misspelled "thesaurus," asked me if I wanted to change it to the correct spelling, and did it when I hit the "y" key.)

I'm not sure what this young doctoral candidate is writing his thesis about. I don't really care. I do care that the academic environment seems to have done things to his mind or to his world view. Apparently, someone at a very fine school hasn't taught him the bare and utter essentials of a college education: (a) how to learn, and (b) how to find information. This is not unusual; I see this all the time and conclude that (1) people haven't learned to use these two vital tools, and/or (2) they're lazy. Probably a bit of both. Or maybe they don't know about them.

I do know that one of the most important things that any scientist, engineer, technologist, inventor, technician, mechanic, or other science buff or technology advocate can and should do is to take a few hours every month or so and visit a Radio Shack store, a local junkyard, an auto repair shop, the drag races, a meeting of amateur astronomers, the local zoo, or any museum available. Barring that, or in addition thereto, get on the mailing list for catalogs—*Edmund Scientific*, for exam-

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ple—and the freebie subscription list for such publications as *Product Design & Development, Electronic Component News, Construction Engineering & Equipment, Computer Design*, and a host of other magazines out there. *Physical Review* and *Science* are excellent scientific research journals, of course, but the other publications show what is really happening in the world of technology. They're fun to read because they prove that someone is out there thinking and making things happen.

Although things do indeed happen in the academic world, it moves at a glacial pace compared to the industrial world where the byword isn't "publish or perish" but "produce or perish." That makes it far more exciting!

In the meantime, technology will continue to help us achieve the Great American Dream. ■

FUTURES

(continued from page 89)

launched, in black and white but still featuring Gilbert's atmospheric art and Ken Bruzenak's striking lettering. (Bruzenak's work has always been an important part of the Mr. Monster saga.)

I picked up the new series with issue number four detailing the Origin of Mr. Monster. The art is as wonderful as ever, with Gilbert's work recalling Wallace Wood (especially his women) and snaggle-toothed kids in the style of Bill Elder. Gilbert also credits a big influence to Steve Ditko, one of the early Marvel artists.

The b&w stories seem to me to be darker, more grim and horrific than the earlier tongue-in-cheek Mr. Monster romps. That was intentional. "My thought," Gilbert explained, "was to start again. A whole other way . . . darker and starker, and let's take advantage of the fact that the series is in black and white." While Mr. Monster's color used to be pretty wild (it was called Terror-Chroma, and boy, did those colors jump and jive), this new incarnation is like seeing the classic Frankenstein and Dracula.

Hollywood has expressed some interest in Gilbert's creation—and it would make a neat movie. And, due this spring, a British anthology, *A-1* will contain an all new Mr. Monster story in color, "Mr. Monster Versus the Invaders From Mars," which promises oodles of references to the mood and milieu of SF in the Fifties.

And, if Mr. Monster hits the spot (and I almost guarantee that it will), I recommend another quirky comic, *Dinosaurs For Hire*. This series, written by Tom Mason and published by Eternity Comics (Malibu Graphics, Inc., 1355 Lawrence Drive 212, Newbury Park, CA 91320), features the free-lance sleuthing of three personable dinosaurs, Archie, Lorenzo and Reese, all with a taste for late night TV and sultry blondes.

So far, there's no indication of where these prehistoric fellows have come from, complete with patter that a young Bob Hope would have admired. Are they from another planet, were they created in a lab, or are they merely robots?

It's too bad Abbot and Costello aren't still with us—they'd be great for the leads in the movie. . . . ■

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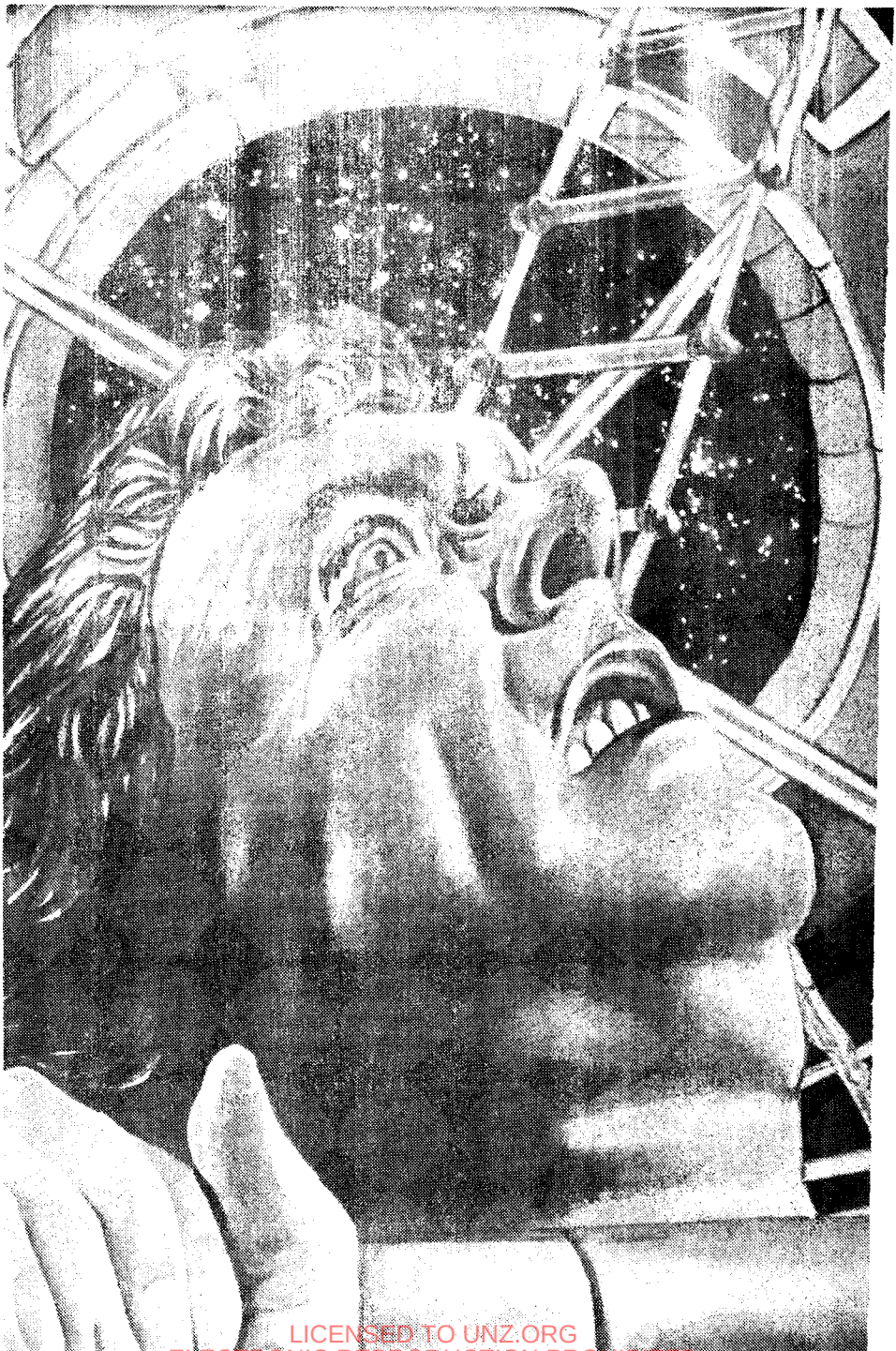

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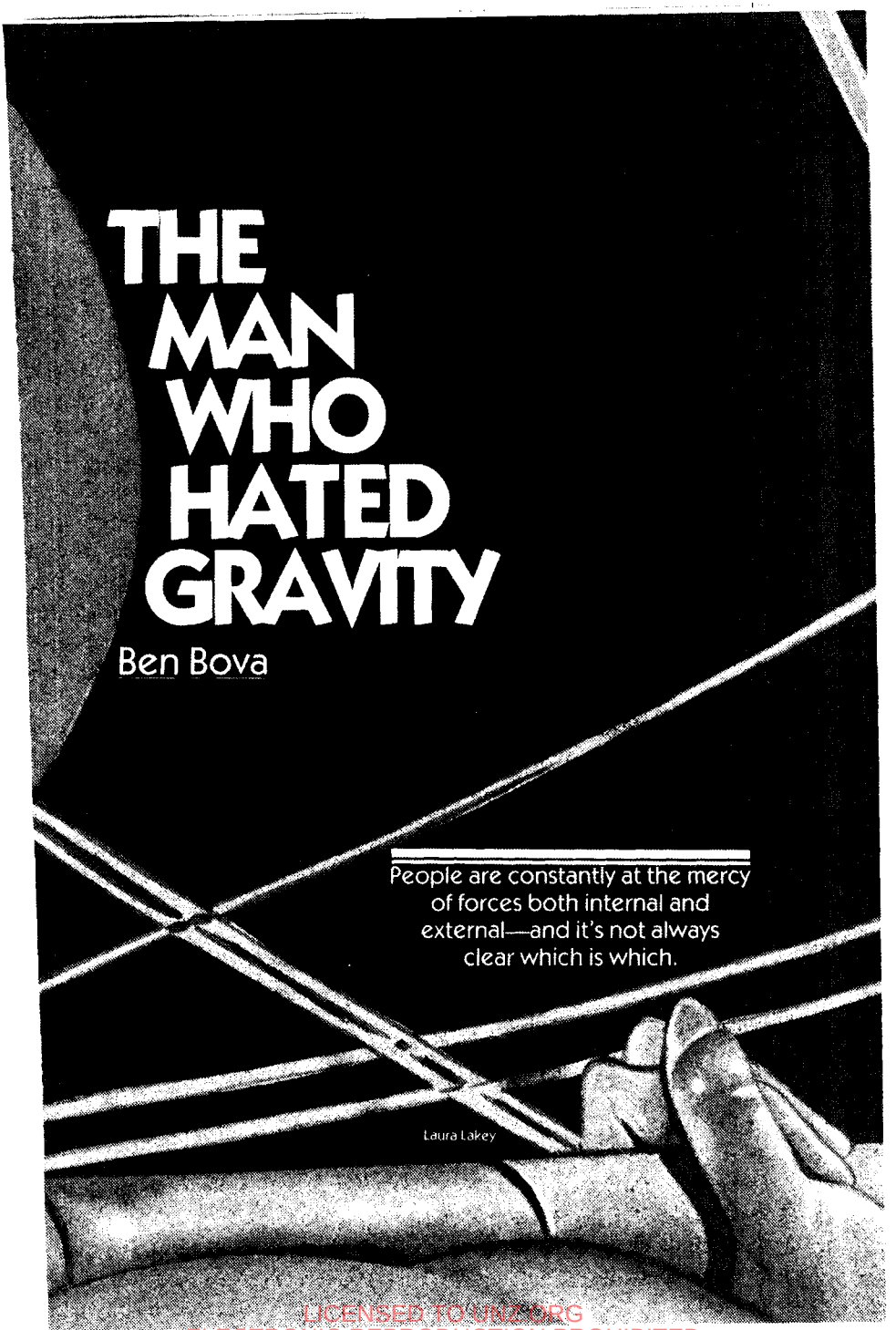
THE MAN WHO HATED GRAVITY

Ben Bova

People are constantly at the mercy of forces both internal and external—and it's not always clear which is which.



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The Great Rolando had not always hated gravity. As a child growing up in the traveling circus that had been his only home, he often frightened his parents by climbing too high, swinging too far, daring more than they could bear to watch.

The son of a clown and a cook, Rolando had yearned for true greatness, and could not rest until he became the most renowned aerialist of them all.

Slim and handsome in his spangled tights, Rolando soared through the empty air thirty feet above the circus' flimsy safety net. Then fifty feet above it. Then a full hundred feet high, with no net at all.

"See the Great Rolando defy gravity!" shouted the posters and TV adversitements. And the people came to crane their necks and hold their breaths as he performed a split second ballet in midair high above them. Literally flying from one trapeze to another, triple somersaults were workaday chores for the Great Rolando.

His father feared to watch his son's performances. With all the superstition born of generations of circus life, he cringed outside the Big Top while the crowds roared deliriously. Behind his clown's painted grin Rolando's father trembled. His mother prayed through every performance until the day she died, slumped over a bare wooden pew in a tiny austere church far out in the midwestern prairie.

For no matter how far he flew, no matter how wildly he gyrated in midair, no matter how the crowds below gasped and screamed their delight, the Great Rolando pushed himself farther, higher, more recklessly.

Once, when the circus was playing New York City's huge Convention Center, the management pulled a public relations coup. They got a brilliant young physicist from Columbia University to pose with Rolando for the media cameras and congratulate him on defying gravity.

Once the camera crews had departed, the physicist said to Rolando, "I've always had a secret yearning to be in the circus. I admire what you do very much."

Rolando accepted the compliment with a condescending smile.

"But no one can *really* defy gravity," the physicist warned. "It's a universal force, you know."

The Great Rolando's smile vanished. "*I* can defy gravity. And I do. Every day."

Several years later Rolando's father died (of a heart seizure, during one of his son's performances) and Rolando married the brilliant young lion tamer who had joined the circus slightly earlier. She was a petite little thing with golden hair, the loveliest of blue eyes, and so sweet a disposition that no one could say anything about her that was less than praise. Even the great cats purred for her.

She, too, feared Rolando's ever-bolder daring, his wilder and wilder reachings on the high trapeze.

"There's nothing to be afraid of! Gravity can't hurt me!" And he would laugh at her fears.

"But I *am* afraid," she would cry.

"The people pay their money to see me defy gravity," Rolando would tell his tearful wife. "They'll get bored if

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I keep doing the same stunts one year after another.''

She loved him dearly, and felt terribly frightened for him. It was one thing to master a large cage full of Bengal tigers and tawny lions and snarling black panthers. All you needed was will and nerve. But she knew that gravity was another matter altogether.

''No one can defy gravity forever,'' she would say, gently, softly, quietly.

''I can,'' boasted the Great Rolando.

But of course he could not. No one could. Not forever.

The fall, when it inevitably came, was a matter of a fraction of a second. His young assistant's hand slipped only slightly in starting out the empty trapeze for Rolando to catch after a quadruple somersault. Rolando almost caught it. In midair he saw that the bar would be too short. He stretched his magnificently trained body to the utmost and his fingers just grazed its tape-wound shaft.

For an instant he hung in the air. The tent went absolutely silent. The crowd drew in its collective breath. The band stopped playing. Then gravity wrapped its invisible tentacles around the Great Rolando and he plummeted, wild-eyed and screaming, to the sawdust a hundred feet below.

''His right leg is completely shattered,'' said the famous surgeon to his wife. She had stayed calm up to that moment, strong and levelheaded while her husband lay unconscious in an intensive care unit.

''His other injuries will heal. But the leg . . .'' The gray-haired, gray-suited man shook his dignified head sadly. His assistants, gathered behind him like an honor guard, shook their heads in metronome synchrony to their leader.

''His leg?'' she asked, trembling.

''He will never be able to walk again,'' the famous surgeon pronounced.

The petite blonde lion tamer crumpled and sagged into the sleek leather couch of the hospital waiting room, tears spilling down her cheeks.

''Unless . . .'' said the famous surgeon.

''Unless?'' she echoed, suddenly wild with hope.

''Unless we replace the shattered leg with a prosthesis.''

''Cut off his leg?''

The famous surgeon promised her that a prosthetic bionic leg would be ''just as good as the original—in fact, even better!'' It would be a *permanent* prosthesis; it would never have to come off, and its synthetic surface would blend so well with Rolando's real skin that no one would be able to tell where his natural leg ended and his prosthetic leg began. His assistants nodded in unison.

Frenzied at the thought that her husband would never walk again, alone in the face of coolly assured medical wisdom, she reluctantly gave her assent and signed the necessary papers.

The artificial leg was part lightweight metal, part composite space-manufactured materials, and entirely filled with marvelously tiny electronic devices and miraculously miniaturized motors that moved the prosthesis exactly the way a real leg should move. It was stronger than flesh and bone, or so the doctors confidently assured the Great Rolando and his wife.

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The circus manager, a constantly frowning bald man who reported to a board of bankers, lawyers, and MBAs in St. Petersburg, agreed to pay the famous surgeon's astronomical fee. "The first aerialist with a bionic leg," he murmured, dollar signs in his eyes.

Rolando took the news of the amputation and prosthesis with surprising calm. He agreed with his wife: better a strong and reliable artificial leg than a ruined real one.

In two weeks he walked again. But not well. He limped. The leg hurt, with a sullen stubborn ache that refused to go away.

"It will take a little time to get accustomed to it," said the physical therapists.

Rolando waited. He exercised. He tried jogging. The leg did not work right. And it ached constantly.

"That's just not possible," the doctors assured him. "Perhaps you ought to talk with a psychologist."

The Great Rolando stormed out of their offices, limping and cursing, never to return. He went back to the circus, but not to his aerial acrobatics. A man who could not walk properly, who had an artificial leg that did not work right, had no business on the high trapeze.

His young assistant took the spotlight now, and duplicated—almost—the Great Rolando's repertoire of aerial acrobatic feats. Rolando watched him with mounting jealousy, his only satisfaction being that the crowds were noticeably smaller than when he had been the star of the show. The circus manager frowned and asked when Rolando would be ready to work again.

"When the leg works right," said Rolando.

But it continued to pain him, to make him awkward and invalid.

That is when he began to hate gravity. He hated being pinned down to the ground like a worm, a beetle. He would hobble into the Big Top and eye the fliers' platform a hundred feet over his head and know that he could not even climb the ladder to reach it. He grew angrier each day. And clumsy. And obese. The damned false leg *hurt*, no matter what those expensive quacks said. It was *not* psychosomatic. Rolando snorted contempt for their stupidity.

He spent his days bumping into inanimate objects and tripping over tent ropes. He spent his nights grumbling and grousing, fearing to move about in the dark, fearing even that he might roll off his bed. Whenever he managed to sleep the same nightmare gripped him: he was falling, plunging downward eternally while gravity laughed at him, and all his screams for help did him no good whatsoever.

His former assistant grinned at him whenever they met. The circus manager took to growling about Rolando's weight, and asking how long he expected to be on the payroll when he was not earning his keep.

Rolando limped and ached. And when no one could see him, he cried. He grew bitter and angry, like a proud lion that finds itself caged forever.

Representatives from the bionics company that manufactured the prosthetic leg visited the circus, their faces grave with concern.

"The prosthesis should be working just fine," they insisted.

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Rolando insisted even more staunchly that their claims were fraudulent. "I should sue you and the barbarian who took my leg off."

The manufacturer's reps consulted their home office and within the week Rolando was whisked to San Jose in their company jet. For days on end they tested the leg, its electronic innards, the bionic interface where it linked with Rolando's human nervous system. Everything checked out perfectly. They showed Rolando the results, almost with tears in their eyes.

"It should work fine."

"It does not."

In exchange for a written agreement not to sue them, the bionics company gave Rolando a position as a "field consultant," at a healthy stipend. His only duties were to phone San Jose once a month to report on how the leg felt. Rolando delighted in describing each and every individual twinge, the awkwardness of the leg, how it made him limp.

His wife was the major earner now, despite his monthly consultant's fee. She worked twice as hard as ever before, and began to draw crowds that held their breaths in vicarious terror as they watched the tiny blonde place herself at the mercy of so many fangs and claws.

Rolando traveled with her as the circus made its tour of North America each year, growing fatter and unhappier day by humiliating, frustrating, painful day.

Gravity defeated him every hour, in a thousand small ways. He would read a magazine in their cramped mobile home until, bored, he tossed it onto the table. Gravity would slyly tug at its pages until the magazine slipped over the table's edge and fell to the floor. He would shower laboriously, hating the bulging fat that now encumbered his once-sleek body. The soap would slide from his hands while he was half-blinded with suds. Inevitably he would slip on it and bang himself painfully against the shower wall.

If there was a carpet spread on the floor, gravity would contrive to have it entangle his feet and pull him into a humiliating fall. Stairs tripped him. His silverware clattered noisily to the floor in restaurants.

He shunned the Big Top altogether, where the people who had once paid to see him soar through the air could see how heavy and clumsy he had become. Even though a nasty voice in his mind told him that no one would recognize the fat old man he now was as the once-magnificent Great Rolando.

As the years stretched past Rolando grew grayer and heavier and angrier. Furious at gravity. Bellowing, screaming, howling with impotent rage at the hateful tricks gravity played on him every day, every hour. He took to leaning on a cane and stumping around their mobile home, roaring helplessly against gravity and the fate that was killing him by inches.

His darling wife remained steadfast and supportive all through those terrible years. Other circus folk shook their heads in wonder at her. "She spends all day with the big cats and then goes home to more roaring and spitting," they told each other.

Then one winter afternoon, as the sun threw long shadows across the Houston Astrodome parking lot, where the circus

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was camped for the week, Rolando's wife came into their mobile home, her sky-blue workout suit dark with perspiration, and announced that a small contingent of performers had been invited to Moonbase for a month.

"To the Moon?" Rolando asked, incredulous. "Who?"

The fliers and tightrope acts, she replied, and a selection of acrobats and clowns.

"There's no gravity up there," Rolando muttered, suddenly jealous. "Or less gravity. Something like that."

He slumped back in the sofa without realizing that the wonderful smile on his wife's face meant that there was more she wanted to tell him.

"We've been invited, too!" she blurted, and she perched herself on his lap, threw her arms around his thick neck, and kissed him soundly.

"You mean you've been invited," he said darkly, pulling away from her embrace. "You're the star of the show; I'm a has-been."

She shook her head, still smiling happily. "They haven't asked me to perform. They can't bring the cats up into space. The invitation is for the Great Rolando and his wife to spend a month up there as guests of Moonbase Inc.!"

Rolando suspected that the bionics company had pulled some corporate strings. They want to see how their damnable leg works without gravity, he was certain. Inwardly, he was eager to find out, too. But he let no one know that, not even his wife.

To his utter shame and dismay, Rolando was miserably sick all the long three days of the flight from Texas to Moonbase. Immediately after takeoff the spacecraft carrying the circus performers was in zero gravity, weightless, and Rolando found that the absence of gravity was worse for him than gravity itself. His stomach seemed to be falling all the time while, paradoxically, anything he tried to eat crawled upward into his throat and made him violently ill.

In his misery and near-delirium he knew that gravity was laughing at him.

Once on the Moon, however, everything became quite fine. Better than fine, as far as Rolando was concerned. While clear-eyed young Moonbase guides in crisp uniforms of amber and bronze demonstrated the cautious shuffling walk that was needed in the gentle lunar gravity, Rolando realized that his leg no longer hurt.

"I feel fine," he whispered to his wife, in the middle of the demonstration. Then he startled the guides and his fellow circus folk alike by tossing his cane aside and leaping five meters into the air, shouting at the top of his lungs, "I feel *wonderful!*"

The circus performers were taken off to special orientation lectures, but Rolando and his wife were escorted by a pert young redhead into the office of Moonbase's chief administrator.

"Remember me?" asked the administrator, as he shook Rolando's hand and half-bowed to his wife. "I was the physicist at Columbia who did that TV commercial with you six or seven years ago."

Rolando did not in fact remember the man's face at all, although he did recall his warning about gravity. As he sat down in the chair the administrator proffered, he frowned slightly.

The administrator wore zippered cov-

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eralls of powder blue. He hiked one hip onto the edge of his desk and beamed happily at the Rolandos. "I can't tell you how delighted I am to have the circus here, even if it's just for a month. I really had to sweat blood to get the corporation's management to OK bringing you up here. Transportation's still quite expensive, you know."

Rolando patted his artificial leg. "I imagine the bionics company paid their fair share of the costs."

The administrator looked slightly startled. "Well, yes, they have picked up the tab for you and Mrs. Rolando."

"I thought so."

Rolando's wife smiled sweetly. "We are delighted that you invited us here."

They chatted a while longer and then the administrator personally escorted them to their apartment in Moonbase's tourist section. "Have a happy stay," he said, by way of taking his leave.

Although he did not expect to, that is exactly what Rolando did for the next many days. Moonbase was marvelous! There was enough gravity to keep his insides behaving properly, but it was so light and gentle that even his obese body with its false leg felt young and agile again.

Rolando walked the length and breadth of the great Main Plaza, his wife clinging to his arm, and marveled at how the Moonbase people had landscaped the expanse under their dome, planted it with grass and flowering shrubs. The apartment they had been assigned to was deeper underground, in one of the long corridors that had been blasted out of solid rock. But the quarters were no smaller than their mobile home back on Earth, and it had a video screen that took up one entire wall of the sitting room.

"I love it here!" Rolando told his wife. "I could stay forever!"

"It's only for one month," she said softly. He ignored it.

Rolando adjusted quickly to walking in the easy lunar gravity, never noticing that his wife adjusted just as quickly (perhaps even a shade faster). He left his cane in their apartment and strolled unaided each day through the shopping arcades and athletic fields of the Main Plaza, walking for hours on end without a bit of pain.

He watched the roustabouts that had come up with him directing their robots to set up a Big Top in the middle of the Plaza, a gaudy blaze of colorful plastic and pennants beneath the great gray dome that soared high overhead.

The Moon is marvelous, thought Rolando. There was still gravity lurking, trying to trip him up and make him look ridiculous. But even when he fell, it was so slow and gentle that he could put out his powerful arms and push himself up to a standing position before his body actually hit the ground.

"I love it here!" he said to his wife, dozens of times each day. She smiled and tried to remind him that it was only for three more weeks.

At dinner one evening in Moonbase's grander restaurant (there were only two, not counting cafeterias) his earthly muscles proved too strong for the Moon when he rammed their half-finished bottle of wine back into its aluminum ice bucket. The bucket tipped and fell off the edge of the table. But Rolando snatched it with one hand in the midst of its languid fall toward the floor and

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with a smile and a flourish deposited the bucket, with the bottle still in it, back on the table before a drop had spilled.

"I love it here," he repeated for the fortieth time that day.

Gradually, though, his euphoric mood sank. The circus began giving abbreviated performances inside its Big Top, and Rolando stood helplessly pinned to the ground while the spotlights picked out the young fliers in their skintight costumes as they tumbled slowly, dreamily through the air between one trapeze and the next, twisting, tumbling, soaring in the soft lunar gravity in ways that no one had ever done before. The audience gasped and cheered and gave them standing ovations. Rolando stood rooted near one of the tent's entrances, deep in shadow, wearing a tourist's pale green coveralls, choking with envy and frustrated rage.

The crowds were small—there were only a few thousand people living at Moonbase, plus perhaps another thousand tourists—but they shook the plastic tent with their roars of delight.

Rolando watched a few performances, then stayed away. But he noticed at the Olympic-sized pool that raw teenagers were diving from a thirty-meter platform and doing half a dozen somersaults as they fell languidly in the easy gravity. Even when they hit the water the splashes they made rose lazily and then fell back into the pool so leisurely that it seemed like a slow motion film.

Anyone can be an athlete here, Rolando realized as he watched tourists flying on rented wings through the upper reaches of the Main Plaza's vaulted dome.

Children could easily do not merely Olympic, but Olympian feats of acrobatics. Rolando began to dread the possibility of seeing a youngster do a quadruple somersault from a standing start.

"Anyone can defy gravity here," he complained to his wife, silently adding, Anyone but me.

It made him morose to realize that feats which had taken him a lifetime to accomplish could be learned by a toddler in half an hour. And soon he would have to return to Earth with its heavy, oppressive, mocking gravity.

I know you're waiting for me, he said to gravity. You're going to kill me—if I don't do the job for myself first.

Two nights before they were due to depart they were the dinner guests of the chief administrator and several of his staff. As formal an occasion as Moonbase ever has, the men wore sport jackets and turtleneck shirts, the women real dresses and jewelry. The administrator told hoary old stories of his childhood yearning to be in the circus. Rolando remained modestly silent, even when the administrator spoke glowingly of how he had admired the daring feats of the Great Rolando—many years ago.

After dinner, back in their apartment, Rolando turned on his wife. "You got them to invite us up here, didn't you?"

She admitted. "The bionics company told me that they were going to end your consulting fee. They want to give up on you! I asked them to let us come here to see if your leg would be better in low gravity."

"And then we go back to Earth."

"Yes."

"Back to *real* gravity. Back to my being a cripple!"

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"I was hoping . . ." Her voice broke and she sank onto the bed, crying.

Suddenly Rolando's anger was overwhelmed by a searing, agonizing sense of shame. All these years she had been trying so hard, standing between him and the rest of the world, protecting him, sheltering him. And for what? So that he could scream at her for the rest of his life?

He could not bear it any longer.

Unable to speak, unable to even reach his hand out to comfort her, he turned and lumbered out of the apartment, leaving his wife weeping alone.

He knew where he had to be, where he could finally put an end to this humiliation and misery. He made his way to the Big Top.

A stubby gunmetal gray robot stood guard at the main entrance, its sensors focusing on Rolando like the red glowing eyes of a spider.

"No access at this time except to members of the circus troupe," it said in a synthesized voice.

"I am the Great Rolando."

"One moment for voiceprint identification," said the robot, then, "Approved."

Rolando swept past the contraption with a snort of contempt.

The Big Top was empty at this hour. Tomorrow they would start to dismantle it. The next day they would head back to Earth.

Rolando walked slowly, stiffly, to the base of the ladder that reached up to the trapezes. The spotlights were shut down. The only illumination inside the tent came from the harsh working lights spotted here and there.

Rolando heaved a deep breath and stripped off his jacket. Then, gripping one of the ladder's rungs, he began to climb: good leg first, then the artificial leg. He could feel no difference between them. His body was only one-sixth its Earthly weight, of course, but still the artificial leg behaved exactly as his normal one.

He reached the topmost platform. Holding tightly to the side rail he peered down into the gloomy shadows a hundred feet below.

With a slow, ponderous nod of his head the Great Rolando finally admitted what he had kept buried inside him all these long anguished years. Finally the concealed truth emerged and stood naked before him. With tear-filled eyes he saw its reality.

He had been living a lie for all these years. He had been blaming gravity for his own failure. Now he understood with precise, final clarity that it was not gravity that had destroyed his life.

It was fear.

He stood rooted on the high platform, trembling with the memory of falling, plunging, screaming terror. He knew that this fear would live within him always, for the remainder of his life. It was too strong to overcome; he was a coward, probably had always been a coward, all his life. All his life.

Without consciously thinking about it Rolando untied one of the trapezes and gripped the rough surface of its taped bar. He did not bother with resin. There would be no need.

As if in a dream he swung out into the empty air, feeling the rush of wind ruffling his gray hair, hearing the creak of the ropes beneath his weight.

Once, twice, three times he swung

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back and forth, kicking higher each time. He grunted with the unaccustomed exertion. He felt sweat trickling from his armpits.

Looking down, he saw the hard ground so far below. One more fall, he told himself. Just let go and that will end it forever. End the fear. End the shame.

"Teach me!"

The voice boomed like cannon fire across the empty tent. Rolando felt every muscle in his body tighten.

On the opposite platform, before him, stood the chief administrator, still wearing his dinner jacket.

"Teach me!" he called again. "Show me how to do it. Just this once, before you have to leave."

Rolando hung by his hands, swinging back and forth. The younger man's figure standing on the platform came closer, closer, then receded, dwindled as inertia carried Rolando forward and back, forward and back.

"No one will know," the administrator pleaded through the shadows. "I promise you; I'll never tell a soul. Just show me how to do it. Just this once."

"Stand back," Rolando heard his own voice call. It startled him.

Rolando kicked once, tried to judge the distance and account for the lower gravity as best as she could, and let go of the bar. He soared too far, but the strong composite mesh at the rear of the platform caught him, yieldingly, and he was able to grasp the side railing and stand erect before the young administrator could reach out and steady him.

"We both have a lot to learn," said the Great Rolando. "Take off your jacket."

For more than an hour the two men swung high through the silent shadowy air. Rolando tried nothing fancy, no leaps from one bar to another, no real acrobatics. It was tricky enough just landing gracefully on the platform in the strange lunar gravity.

The administrator did exactly as Rolando instructed him. For all his youth and desire to emulate a circus star, he was no daredevil. It satisfied him completely to swing side-by-side with the Great Rolando, to share the same platform.

"What made you come here tonight?" Rolando asked as they stood gasping sweatily on the platform between turns.

"The security robot reported your entry. Strictly routine: I get all such reports piped to my quarters. But I figured this was too good a chance to miss!"

Finally, soaked with perspiration, arms aching and fingers raw and cramping, they made their way down the ladder to the ground. Laughing.

"I'll never forget this," the administrator said. "It's the high point of my life."

"Mine too," said Rolando fervently. "Mine too."

Two days later the administrator came to the rocket terminal to see off the circus troupe. Taking Rolando and his wife to one side, he said in a low voice that brimmed with happiness, "You know, we're starting to accept retired couples for permanent residence here at Moonbase."

Rolando's wife immediately re-

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sponded, "Oh, I'm not ready to retire yet."

"Nor I," said Rolando. "I'll stay with the circus for a few years more, I think. There might still be time for me to make a comeback."

"Still," said the administrator, "when you do want to retire. . . ."

Mrs. Rolando smiled at him. "I've noticed that my face looks better in this lower gravity. I probably wouldn't need a facelift if we come to live here."

They laughed together.

The rest of the troupe was filing into the rocket that would take them back to Earth. Rolando gallantly held his wife's arm as she stepped up the ramp and ducked through the hatch. Then he turned to the administrator and asked swiftly:

"What you told me about gravity all those years ago—is it really true? It is really universal? There's no way around it?"

"Afraid not," the administrator answered. "Someday gravity will make the Sun collapse. It might even make the entire Universe collapse."

Rolando nodded, shook the man's hand, then followed his wife to his seat inside the rocket's passenger compartment. As he listened to the taped safety lecture and strapped on his safety belt, he thought to himself: So gravity will get us all in the end.

Then he smiled grimly. But not yet. Not yet. ■

●Perseverance: a lowly virtue whereby mediocrity achieves an inglorious success.

Ambrose Bierce

●You may get a large amount of truth into a brief space.

Henry W. Beecher

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THE ANALYTICAL LABORATORY

It's time again to thank everyone who voted in our annual poll on the previous year's issues (and gently chide those who didn't). The feedback your votes provide has always been very useful to us—and consequently to you if an author or artist does an especially good job of entertaining you, he or she would certainly appreciate your thanks. This is the most meaningful way I know for you to convey them, and the more votes we get, the more meaningful it is. It also helps us to keep aware of what you like, so we'll know what to offer you in the future.

To review the procedure, we have four categories: novellas and novelettes, short stories, fact articles, and covers. In each category, we asked you to list your three favorite items, in descending order of preference. Each first place vote counted as three points, second place two, and third place one. The total number of points for each item was divided by the maximum it *could* have received (if everyone had ranked it #1) and multiplied by 10. The result is the score listed below, on a scale of 0 (nobody voted for it) to 10 (everybody liked it best). In practice, scores run lower in categories with many entries than in those with only a few. For comparison, I've included in parentheses at the head of each category the score every item would have received had all been equally popular.

NOVELLAS AND NOVELETTES (0.54)

1. "Sanctuary," James White (1.87)
2. "Peaches for Mad Molly," Steven Gould (1.79)
3. "Guz's Place," Timothy Perper & Martha Cornog (1.54)
4. "Remember'd Kisses," Michael F. Flynn (1.09)
5. "The Reading Lesson," Stephen L. Burns (1.00)

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SHORT STORIES (0.49)

1. "The Circus Horse," Amy Bechtel (1.32)
2. "Frame of Reference," Stephen Kraus (1.30)
3. "Siren," A.J. Austin (1.22)
4. "If You Wish Upon a Star. . .," Jerry Oltion (1.12)
5. "User Friendly," Alice Laurance (0.97)

FACT ARTICLES (1.67)

1. "An Introduction to Psychohistory," Michael F. Flynn (3.57)
2. "Extraterrestrial Intelligence and the Interdict Hypothesis," Martyn J. Fogg (2.83)
3. "24th Century Medicine," Thomas Donaldson (2.29)
4. "Building a Better Biosphere," Greg Stec (2.26)
5. "Laughing All the Way to Orbit," G. Harry Stine & Wilfred C. Smith (2.02)

COVERS (1.54)

1. February: Vincent Di Fate, for *Falling Free* (3.17)
2. December: Ron and Val Lindahn, for "Sanctuary" (3.01)
3. Mid-December: Alan Gutierrez, for "Guz's Place" (1.99)
4. May: Janet Aulisio, for "Hunting Rights" (1.96)
5. August: Vincent di Fate, for *Proteus Unbound* (1.88)

There was a small amount of confusion about "An Introduction to Psychohistory," since it ran in two parts and a few people voted for them separately; but by any method of counting, it was the runaway favorite in its class. Its author, Michael F. Flynn, also had three stories among the top nine novellas and novelettes. New authors made an impressive showing in both fiction categories, which should put to rest any unfounded suspicions that either editors or readers discriminate against new talent. And while I normally only list the top five items in each category, this time an honorable mention seems obligatory for short stories, where three stories were tied a minuscule distance behind the top winners: Pauline Ashwell's "Thingummy Hall," Paula Robinson's "Can you Spare an Elephant?," and Gail Schnirch's "A Cat for Katie."

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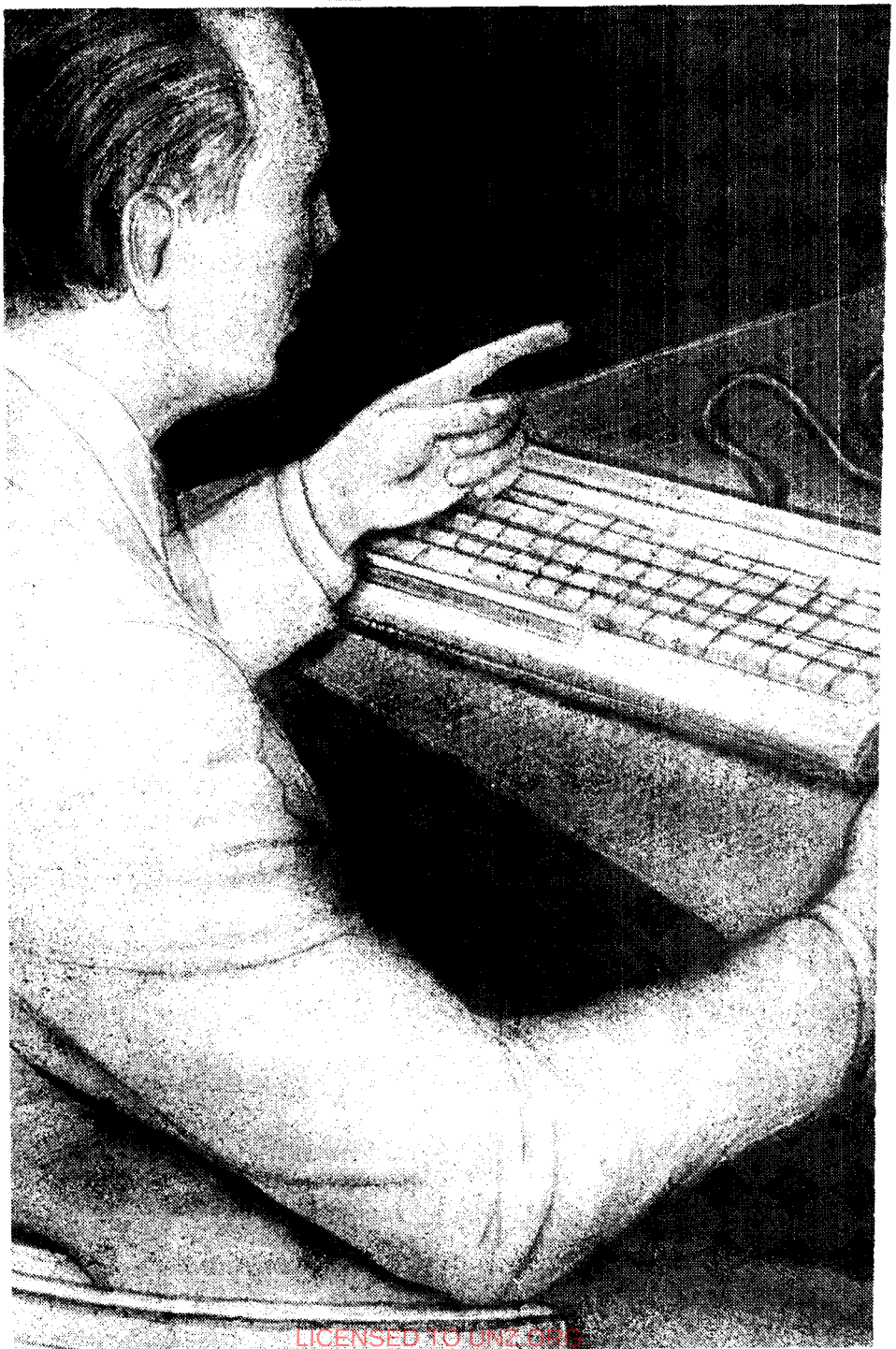

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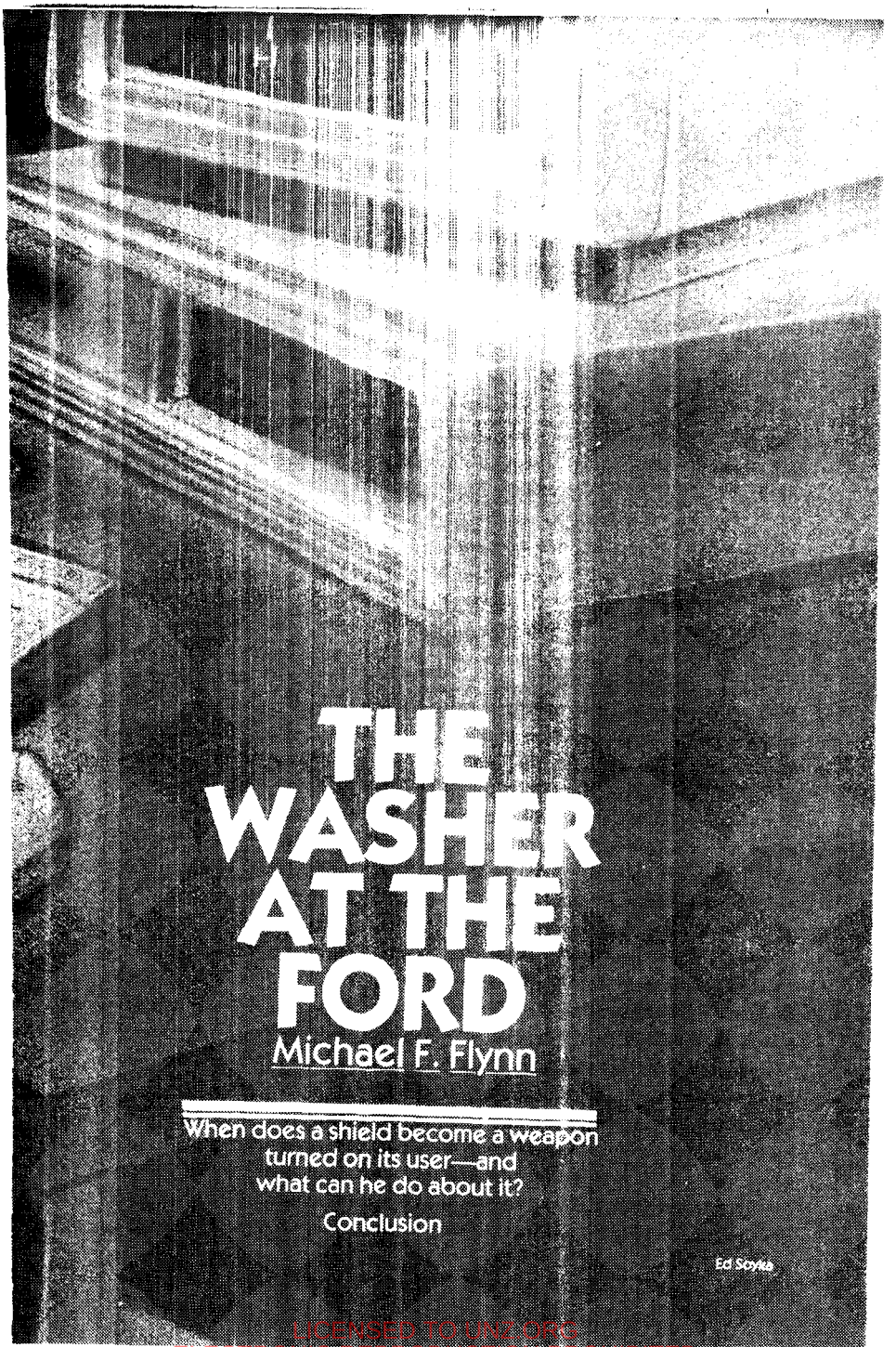

THE WASHER AT THE FORD

Michael F. Flynn

When does a shield become a weapon turned on its user—and what can he do about it?

Conclusion

Ed Soyka

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SYNOPSIS

Charles Randolph Singer, *the "Thomas Edison" of biotechnology, uses a momentary lapse of attention on the part of his tour guide to enter the containment structure of a nuclear power plant. The reactor plenum has been cracked for fuel rod replacement, and the interior of the containment is highly radioactive. In full view of the remaining tourists, he takes out a paperback book and sits down to read. As he reads, he is haunted by voices:* "You don't take failure very well." "Please don't talk yourself into doing something I can't live with." "There are no final solutions, Charlie."

How did it come to this? *he asks himself. But it is a rhetorical question, because he remembers every step and stumble along the way:*

Biophysicist **Masao Koyanagi** *arrives at SingerLabs, in Menlo Park, NJ, with an idea for a nanomachine that will harden humans to the effects of radiation. The Lab is in a precarious financial situation, and Singer sees possible salvation in Koyanagi's idea. There would be great demand among cosmonauts and workers in nuclear and orbital factories. But Singer welcomes Koyanagi to the staff with some reservations. As an employee of São Paulo Biophysics, Koyanagi had once pirated a protein of Singer's.*

The staff discusses the technological problems they expect to encounter in the design and development of the "rad nanny." In addition to Singer and Koyanagi, the staff includes: Singer's wife, **Jessica Burton-Peeler**, *a geneticist who had been his college rival and sweetheart;* **Kalpit Patel**, *a microbiologist; and* **Eamonn Murchadha**, *the nanomachinist. Singer emphasizes the gamble involved, given their current financial state. Research and development expenses are likely to be high; and success uncertain. Peeler suggests that it might be better not to start the project at all. Koyanagi is shocked.*

After the meeting, Koyanagi expresses a worry to Singer that the nanny may be too expensive. It should be made available to all, not only those who can afford it. Singer scoffs at his fears. Market forces will take care of things, and the cost will eventually come down. Meanwhile, he sees no reason to sacrifice his own profits. The Lab has bills to pay, too.

Koyanagi's original concept proves to be unworkable. It exceeds the capacity of their nanoprocessor, Tiny NIM. However, Patel and Murchadha develop a compromise in which cell repair is confined to critical tissues. While other radiation damage will be excised by "killer cells." Singer gives the design his go-ahead.

When Singer attempts to evaluate the limits of the design envelope, he discovers that the maximum protection of the nanny is far below useful levels. He experiences a nightmare, with confused images of failure and poverty. Awakening, he tells Peeler that the data used for the simulation might have been garbled by transmission noise. Peeler wonders if that is not wishful thinking on his part. Later, Singer repeats the simulation, first assuring the correctness of the data, and finds the design capability to be adequate. He realizes that, regard-

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less where the limits are set, there will be circumstances in which the radiation level is more than the nanny can handle without "baking" the patient in its own waste heat. But better that some should die because the nanny is too weak than that any should die because it is too strong. People react hysterically to medical treatments that are sometimes fatal. It would destroy the market.

That night, he finds Jessie hunting up a midnight snack. She has been working all evening in the lab and tells Singer that she has finally resolved the problem of building blueprints from the cell's DNA. By checking the DNA strands in triplicate, random codon errors can be detected and disregarded. Singer thinks the solution simple and wonders why it took so long.

Peeler has thought of a new problem: The nannies themselves can be damaged by radiation. If they malfunction, they could harm the patient. Singer is disturbed and Peeler asks whether there might not be more such problems; perhaps enough to sink the project. Maybe it's time to cut their losses. Singer says that they are in too deep financially to back out now. The nanny must work or the Lab will go under.

The project moves too slowly. Everything takes longer than it should. Test failures, redesigns, blind alleys. Even nuisance equipment failures. Such stumbling blocks plague any project; but the criticality of this project magnifies their importance in Singer's mind.

The financial situation deteriorates to the point that Singer feels compelled to go to the banks for a loan. He hates owing money. He is haunted by memories of his family's grinding poverty in the Kentucky coal fields; and of an earlier business failure when, creditors having nearly destroyed his company, he had seriously contemplated suicide.

But the banks refuse to lend him anything, since he will not divulge the nature of the collateral. On the train back from New York, Singer encounters **John Royce**, *a government agent with the Bureau of Technology Assessment. Royce has deduced the nature of Singer's project from taps on the Data Net. Singer is angry at the invasion of privacy, but Royce argues that community interests sometime override private interests. Besides, he says, the government is willing to underwrite the costs of the project and to undertake the production and distribution. He hints that, unless Singer accepts this offer, the government will leak the idea to another nanotech firm. Though disturbed by the implicit threat and the not-so-subtle appeal to his well-known love of money, Singer is favorably inclined. Not only will the deal resolve the Lab's cash problem, but it will also satisfy Koyanagi's desire for wider availability of the nanny.*

When he tells Jessie about the government offer, however, she becomes angry. The government is like a camel: invite its nose into the tent and pretty soon the rest of him is in there, too. Singer points out that, without government financing, the Lab will go under. He accuses her of being negative, always pointing out problems. She responds by accusing him of a pollyannaish attitude. His fear of poverty is blinding him to reality, so that he overlooks real difficulties. Singer tells her that she does

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not have enough shares to block the vote, since Koyanagi—and probably the others as well—will vote Singer's way.

Singer and Royce have lunch in a restaurant anchored in Raritan Bay. From it Singer is reminded of his first nanomachine, Plastiphage, which destroys plastic waste and refuse in the water. The design was pirated by General Molecule. Singer is determined that that will never happen again, which is why he now insists on absolute secrecy on projects even after market launch.

Royce talks about his work. Unlike so many others, who use patriotism and government service as a cloak for personal enrichment or cynical exploitation, Royce is sincere in his beliefs. He is a Sawyerite, a member of a fundamentalist religious sect. Someone, he says, must put the interests of the country ahead of career advancement and other selfish matters. Singer points out that the public interest is not always that clear, citing the replacement of a nuclear power plant with coal-fired plants as an example. Leaving the greenhouse issue aside, the coal plants spew out more radiation than the nuclear plants. Royce is surprised and Singer mentions many other sources of everyday radiation, from bricks to tobacco.

As they leave the restaurant, they notice a group of Green protestors at the pier where the Plastiphage ships dock. Royce wonders why they are protesting here rather than at the landfill. Singer says that both the smell and the media access is better on this side of the Arthur Kill.

A few days later, Singer falls into a late evening discussion with Murchadha, who is concerned about the psychological side effects of the nanny. If the public is hardened to radiation, he says nuclear plant operators may become careless. Managers may decide to cut back on maintenance and safety. Safety precautions will seem less important. Many policemen, he says, refuse to wear bulletproof vests for that reason. Yet the nanny does not confer total immunity; nor does it protect animals and plants. The result may be worse than if no nanny were available.

But there is something else disturbing the young nanomachinist. Murchadha hesitates, then tells Singer the myth of the Washer at the Ford—how the Daghdha, an Irish god, discovered that a woman doing her wash in the river was actually the Morrighan, the triune goddess of war, and that her laundry consisted of the heads and limbs of those to be slain in the fight.

Puzzled, Singer asks how the story relates to the nanny. Murchadha tells him that it was the Morrighan's cleansing itself that brought death and suggests that, by increasing resistance to fallout—and thus reducing the penalties of war—the radiation nanny may make nuclear war more likely. Singer tells him he is being absurd. Murchadha counters that politicians are no brighter than businessmen when it comes to technical matters. Besides, he would rather worry and be wrong than not *worry and be wrong. It's me duty to worry, he says. Murchadha being the Gaelic form of Murphy.*

That night, Singer is again haunted by a surrealistic nightmare. The Lab, a dirt-floor cabin. Patel complaining

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that two of his molecules won't fit properly. Murchadha sewing vests, and Royce stacking them in piles. Koyanagi copying minidisks. Green protestors marching through the Lab. In the dream, he embraces Jessie only to watch her transform into the frightening visage of the Morrighan.

The next morning, Royce calls and tells Singer he must dismiss Koyanagi. The government is sitting on the appropriation because Koyanagi is a citizen of the Japanese-Brazilian Co-Dominium, a "Brass Jap" in current parlance. Singer argues that without Koyanagi's talents, development of the nanny will be impossible. Royce points out that, once development is complete, Koyanagi will no longer be indispensable. The government, he says, will reimburse Singer generously for the cost of replacing the Brazilian.

Royce also reminds Singer that Koyanagi has already pirated from SingerLabs once before. This disturbs the Committee, and should disturb Singer. Afterwards, Singer does wonder why Koyanagi came to him. Because we're friggin' geniuses, that's why. *Koyanagi needed a breakthrough to make his idea workable; but what if his plan has always been to take the design back to São Paulo?*

Singer cradles the phone and stares at it. Cost plus. How much for stringing Masao along, then dumping him? Thirty pieces of silver? What was the alternative? Losing the contract and the Lab. Throwing Eamonn and Kalpit on the street. He and Jessie losing everything they had worked to build. It is expedient that one man die for the whole nation. Is it also expedient that one man be fired for the whole Lab? He thinks about it long and hard, but finds no easy answers.

Patel reports on potential nanny failures. A novel method of analysis has indicated that all but two of the structures they have designed are fail-safe. Singer thinks this is good news, but Patel seems unhappy. Singer presses him and he reveals his belief that at least one of the structures involved has been deliberately altered.

Someone is tampering with the design, Patel tells him. To slow it down. Or to sabotage it completely.

There. It was out in the open now. A cold, horrible fact.

The alterations that Patel believes were made are subtle, requiring deep knowledge of nanotechnology. Kalpit looks at Singer and his skin flushes darker. He clasps his hands together, as if he were praying, and lays his forehead on his knuckles. After a while, he looks up and his eyes are pleading. "Masao was my friend," he said.

Then you're thinking the same thing I am. *Singer runs a hand across his chin. "Look, Kal. Don't say anything about this to any of the others. Not even Masao."* Especially *not Masao?* Didn't they steal one of your designs? *Royce had asked.* Shouldn't you wonder what he's up to? *He tells Patel he wants to check into the matter further before saying anything. There is not enough hard evidence.*

Patel nods and leaves without saying anything further. Singer watches him go. Patel? *Sooner or later, Singer would have discovered the sabotage. Had Pa-*

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tel come forward simply to divert suspicion from himself? Perhaps. But what motive could Patel possibly have?

What about Masao? *He had been just outside the office when Royce had demanded his firing. Could he have overheard? But Masao wanted the nanny more than anyone. Still, he disagreed with Singer's marketing strategy. He wanted Free Nannies for All. And he* had *been a party to São Paulo's piracy, hadn't he?*

Then there was Eamonn and his Angst *about the side effects the nanny might have. Could his concern be deep enough that he would try to ruin the project? But Eamonn didn't have the expertise to do so subtle a job. Or did he? Nanomachining required extensive knowledge of molecular structures, and no one was more intimate with the fine details of the design than the machinist.*

Or Jessie? She had been dragging her feet on the project. She had not shown her usual flash and brilliance. Why, Singer didn't know. But lack of enthusiasm was not a motive for sabotage. Try as he might, he couldn't make the connection.

Except for Masao, they had been with him for years. He knew them. They wouldn't do such a thing to him. It just wasn't in them. And that left Masao. The man from São Paulo.

Which would make it much easier to comply with Royce's demand.

Singer turned and spat his gum into the wastebasket. It had gone sour and tasteless.

PART TWO
IX

Royce got off on the wrong foot with Jessie from the moment he complimented her on her dress.

Singer and Burton-Peeler stood in the doorway of the restaurant's cocktail lounge, searching for their host, while their eyes adjusted to the dimness. Royce saw them and waved them over, and they made their way through the chattering lunchtime crowd to his table. He had a half-finished, bright yellow drink in front of him. Singer wondered if it contained any alcohol.

Royce stood and held a chair out for Jessie to sit. "I see you brought the little woman along," he said to Singer. Then he turned to her and said, "That's a very charming dress you're wearing, my dear."

Whoops, thought Singer. He waited for Jessie so say something, but she only smiled and held her peace, and Singer breathed a prayer of thanks. The three of them chatted for a while, exchanging meaningless pleasantries about the weather. Royce twisted in his chair and signalled to the waitress.

"So. How are things going on the project, Charles?" he asked, turning back.

"Not as quickly as I would like," Singer admitted. "But I think I've got a handle on the biggest roadblock, now." Roadblock. That was one way of putting it. He had said nothing of Koyanagi's sabotage to Royce. Considering his earlier warnings about the Niprazilian, Royce would probably take the news as evidence of Singer's bad judgment in defending him. He might drop the funding and move the project elsewhere.

"It's a rather difficult project," Bur-

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ton-Peeler interjected. "I think Charlie understimated the difficulties from the very beginning. He's been very moody the last few days, but he won't say why."

"Hmm. Is there any way to make up for the lost time, Charles?" The waitress arrived at their table and Royce picked up his drink and tossed the rest of it off. He handed her the empty glass. "The same for me, missy. And my friends will want . . ." He glanced inquiringly at Singer and Burton-Peeler. "Feel free. It's on Uncle."

"Gin and bitters," said Jessie.

"Beer," said Singer. "Whatever's on tap and domesticated."

"I've tried to explain, John," he continued after the waitress had left. "Research isn't like production. You can't make it go faster by putting more people on it. You can't expedite it."

"Sometimes," added Jessie, "it depends on a flash of insight. And the flash never comes."

"I suppose." Royce scratched the side of his nose. "I'm not a creative man myself. I admit it. So, I'm not telling you how to do your job, Charles. You know that. I've seen too many projects ruined by colleagues who were too zealous in their oversight. Constantly nit-picking. Changing specifications on a whim. Generally getting in everyone's hair. And as often as not, the end product would not perform anyway; because some key factor was overlooked."

"There may be a connection," Jessie commented, "between overseeing things and overlooking things. Thank you," she added to the waitress, who set their drinks down in front of them. Royce seized his and took a long swallow. Orange juice, thought Singer. It's got to be pure orange juice.

"Excellent." Royce handed the woman a bright red-and-blue ten note. "Keep the change." He looked at Singer. "Oversee and overlook. That's pretty clever. You've got yourself a bright little lady here, Charles."

"I've always thought so," he replied, hoping to forestall Murder One. "So did the University. We both graduated *summa*, you know."

"College sweethearts. I know. I've read your files."

"I've always tried," Dr. Burton-Peeler said sweetly, "to be a credit to my sex."

Singer almost burst out laughing and lifted his mug to hide his face. *Please, Jessie. Keep that hold on your temper. You promised.* It was obvious that she didn't care for Royce. Singer could see that as plain as a tick on a hound dog's ear. It came across in her body language and in the tone of her voice, to which the government man seemed oblivious. Singer knew Jessie was angry; and he knew that the anger would be unleashed later, at him. But at least he knew how to roll with her punches. He wasn't sure how Royce would react. And Royce held the purse.

"I suppose," Royce continued to Burton-Peeler, "that you are working on the woman's angle of the project."

"Woman's angle? There is no—" Jessie began, then stopped and pouted her lips. She cocked her head. "Yes, of course, I am. Someone has to consider the unexpected problems. 'Damn the torpedos' is a workable strategy only if there are no torpedos ahead."

"Hmmm, yes." Royce nodded

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slowly. He looked at Singer. "What is the woman's issue here?" he asked.

"I think I'll let Jessie answer that one. It's her assignment." *Just what the hell has Jess thought of? Royce didn't have anything particular in mind when he made that remark, I'm sure. But it sure made Jessie think of something.*

"Well, it's nothing earth-shattering," she said, twirling the stem of her cocktail glass slowly between her thumb and forefinger. "It's just that not everything in a mother's bloodstream makes it through the placenta into the f—into the baby. We need to assure ourselves that the nanny will protect the unborn as well as the mother."

Damn, thought Singer.

"And, of course, there's Weismann's Barrier, which normally separates germ plasm cells from somatic cells. A general principle of genetics is that somatic changes are not hereditary. That would be Lamarckism, the inheritance of acquired characteristics, a theory that Stalin pushed because he could not accept Darwin. We must assure ourselves that the design permits the nanny to cross the barrier and repair the reproductive material. Otherwise—"

"Otherwise," Royce finished for her, "mothers exposed to radiation could still give birth to deformed babies, even many years later. Could that be a real problem, Charles?"

"Yes," said Burton-Peeler.

"No," said Singer. He looked at his wife and she returned the look calmly. "No problems that genius and creativity can't handle," he continued, holding Jessie's gaze.

"Glad to hear it," Royce said, picking up the menu. "Glad to hear it."

* * *

Dinner was uncomfortable, at least to Singer. Jessie continued to emphasize the difficulties they had had in developing the nanny. Singer just as consistently pointed out how those difficulties had been overcome or, some cases, would be overcome. Once, when Royce excused himself and left the table, Jessie turned to Singer and vented some of her frustrations.

"Your government buddy is a 24-karat chauvinist," she said.

"He's not exactly my buddy."

"Who invited his nose into our tent? I'm sure he's a Sawyerite now. He never heard a word I said. Did you see it?" Singer nodded, but said nothing, knowing that it hadn't been a real question. "I'm only a woman," she continued, "so I cannot have a worthwhile opinion." She twisted her voice into a squeaky imitation of Royce. "What a nice dress, my dear. Oh, are you handling the woman's angle? I could have told him his zipper was on fire and he would have smiled and told me my hair looked nice."

"That's life on the pedestal," Singer said. "Some women like it. Don't take him so seriously. We have to deal with him; so let it roll off your back."

"Easy for you to say. He wasn't being condescending to hillbillies."

"Jess—"

"Besides, I've got to dump on someone, so it might as well be you. I've been a good little girl, haven't I? I didn't kick him where I should have."

She had done that one time, he remembered. The SOB had deserved it, but Singer still winced at the memory.

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When Jessie had a few gins in her she became more than a little unpredictable.

"Look. Try to go easy on the problems we've been having, would you?" he told her. "You keep emphasizing our problems—"

"We have had problems!"

"I know. I know. This project has had more bugs than the Embassy in Rio." He thought again of the sabotage and his voice tightened. "That's not what I meant. If he keeps hearing you bitch about the difficulties, he may think we're hinting around for more money."

Her eyes bored into his. "So let him think that. Maybe he'll up the ante. Why should that bother you? You'll do anything for a NewDollar, won't you?"

Singer looked over Jessie's shoulder and saw Royce returning. "Not anything," he said. "I've never crawled."

"I'm sorry to have to tell you this," Royce said as he wiped his lips with his napkin. He pushed the empty plate from him. "But I haven't been able to convince the committee members on that nationality issue."

Singer grunted. "I didn't think you would." Xenophobia was running rampant in the country since the Embargo and the congresscritters knew enough arithmetic to add votes.

The waitress brought the check and Royce handed her a debit card without checking the figures. He picked up the salt shaker and toyed with it. "Will that cause you any difficulties?"

"Not as many as I had thought before. In fact, it might solve some."

"Oh? Then you've decided you don't really need him?"

"What are you two talking about?" Jessie asked. "Need who?"

Singer grimaced. "The timing has to be right. Like I told you before, we do need his expertise for a while longer. And . . . there are still some things I need to check out. I'll get back to you."

"I'm glad you saw the light on this one, Charles," Royce said with a smile. "We couldn't buck the Joint Committee over just one man; and not even an American, at that. Don't worry, you'll get by without him."

Jessie said nothing until they were seated in their car in the parking lot. She watched Royce's Olds disappear onto Stelton. Singer started to put the keys in the ignition but Jessie reached out and stopped him.

"All right, Charlie . . ." He glanced up and saw the grim look on her face. "You know what part of the camel's anatomy is in the tent now?"

"No, what?"

"The prick."

"What?"

"Yes, he's trying to screw us."

He started to give a flip answer, then thought better of it. Her face told him this was not a joking matter. "What do you mean?" He knew what she meant and had been dreading this moment.

"What was that business back there? Who were you two talking about firing?"

"Firing? Oh."

"Don't 'Oh' me, Charlie. Open up. You know you can't fire anyone. It takes a majority of the shares to force someone out."

His hand reached for his shirt pocket, but Jessie seized him by the wrist. "And

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don't go for the chewing gum, either," she told him. "You do that every time something's bothering you."

Singer twisted his arm in her grip and she let go. "Royce tells me that we won't get the government financing unless we fire Koyanagi."

Her eyes widened. "Koyanagi? Why?"

Singer didn't answer her. "And without the financing, there's no project. And that's the end of the lab."

"Then what's the problem, Charlie?" she said. There was acid in her voice. "Dump the 'gook,' and you'll get wealth beyond the dreams of avarice."

"Don't go slinging clichés at me! I've been rich and I've been poor. And all *things considered, I'd rather be rich.*"

"Now, that's original."

He turned his head and stared out the windshield. "I'm not joking. I was there once. You don't know what it was like."

"You're right, Charlie. I don't. I only know that no amount of money is worth selling out a friend. Not even in Appalachia."

"Don't patronize me! I'm not some sort of Judas. I wouldn't sell a friend for thirty pieces of silver. It's just that . . ."

"Just that what?"

He ran his hands around the steering wheel, then batted it with his hand. "Who says Koyanagi's a friend of ours?"

A frown creased her forehead. "What are you talking about? This whole project was Masao's idea in the first place! He wants this nanny more than anything in the world."

"Sure. *He* wants it."

She gave him an odd look. "What is that supposed to mean? I thought you wanted it, too."

Singer shook his head. "I do, but not the way he does. Look, he doesn't want the nanny built. He wants to build the nanny. Get the difference? He wants to do it himself, and the way things stand now, there's only one way he can."

"I'm not sure what you're getting at."

"Look, if we keep him on, we'll lose the contract. Royce will leak everything to NanoTech or one of the others. They wouldn't hire Koyanagi, either. So whether he stays or goes, he's out of it. Unless . . ."

"Unless what? I don't like where this *is going, Charlie.*"

He gave her a sharp look. "I don't like where it's been! I thought he was our friend."

"He is."

"Friends don't sabotage."

"Sabotage?" Jessie dropped her hand from Singer's arm. She backed away from him. "What sabotage?"

Singer waved his hand at her. "I have evidence. Molecules have been altered, very subtly, to slow the project down and prevent its completion. Kal says it has to have been deliberate, and I believe him. Someone is to blame."

"The new kid on the block."

"Well?" he demanded angrily. "Who else? Eamonn doesn't have the smarts for it. And Kal is the one who told me about it."

Singer balled his right hand into a fist and hammered once on the dashboard. "Dammit!" The dash was padded, but it hurt his hand nonetheless. The pain felt good. "Masao's been the guiding

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light. If he goes, the project might drag out for another couple years."

"We might never finish it at all," said Jessie with an odd twist to her voice.

"I thought I knew him," he said. *But who ever knows another person? Masao doesn't like my attitude. He's made no secret of that. He's a bleeding-heart idealist and I'm a money-sucking mercenary. But I wouldn't have thought he would go this far.* But the trouble with idealists was that they were fond of grand, futile gestures. Sure, Koyanagi wanted to 'benefit humanity.' But he wanted the applause, too. The peer recognition; the gratitude of humanity. Sometimes Singer thought his own monetary motivation was not only simpler, but cleaner. At least, he made no bones about why he scratched where it itched. Everyone wants payment for their work; but those who demanded their payment in intangibles could be far more arrogant and hypocritical than those who just wanted the cash, thank you.

"Why?" said Jessie. "Why would Masao deliberately sabotage his own project?"

"Why? I don't know! Maybe he planned it this way all along. Maybe he was playing us for suckers, so we would help him solve some of his research problems. Maybe he overheard my phone call with Royce and resented being dumped."

"Just a moment! You mean the sabotage is not the reason Royce wants him out?"

"No, he doesn't even know about it. If I told him, he might decide SingerLabs is a bad security risk and cancel the contract anyway."

"Well, we wouldn't want that."

"Don't be sarcastic. No, all the government cares about is that Koyanagi's a 'Brass Jap,' a citizen of the Co-Dominium."

"So, you were going to try squeezing him out even before you discovered the sabotage. Is that right?"

"I . . ." He wouldn't look at her. "No. I was playing for time." He wouldn't look too closely at himself, either. What would he have done? He wanted to believe he would have done the right thing; but it was impossible to remember clearly the feelings of the past, given the feelings of the present. "I thought if I strung it out long enough, something might have come up."

"Maybe the horse will learn to sing."

"What?"

"Never mind," she said bitterly. "Play it your own way, Charlie. You always do. Just one thing."

"What's that?"

"I know you, Charlie. I know you like a book. I know every damn misprint and torn page between your covers. So, please, don't talk yourself into doing something that I can't live with."

X

Singer lay awake in the middle of the night with a knot in his stomach. I have to *know*. He lay on his back in the bed, gazing up at the blackness of the ceiling. Beside him, Jessie snored gently on her side. It had taken her forever to fall asleep.

He had *trusted* Koyanagi, and the little Jap had betrayed him. If he was going to believe in betrayal—believe

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such a thing of anyone—he needed hard evidence, not deduction. Maybe I'm wrong. Maybe Kalpit was wrong. Maybe there was a harmless explanation for everything. An outsider. A hacker. Not a harmless explanation, exactly, but at least one he could live with. He wondered if that was what Jessie had been trying to get at in the car, earlier in the day. Don't do anything I can't live with.

(Of course, she expected him to guess what she meant. She always did. Was he a mind reader? Was he supposed to read her every mood?)

And Kalpit. Kalpit suspected Koyanagi, but he would want hard evidence before he would believe it. He and Koyanagi had become friends.

Christ! Did it matter who it was who was doing it? It was someone's friend. Everyone's friend. No wonder there was a knot in his stomach and the clock read one in the morning.

Gently, he eased the blanket back and slipped out of bed. He picked up his robe and house-shoes and, grabbing his key ring from the dresser, crept out of the bedroom, shutting the door silently behind him.

He didn't bother turning on the lights in the Lab. The windows were made of diamond glass, assembled molecule by molecule in Eamonn's tanks, and they admitted enough light from the streetlamps to throw everything in the room into a ghostly relief. He knew the floor plan well enough to walk it in pitch black.

From his office, he retrieved the copies of the altered structures that Kalpit had given him. Then he sat at Koyanagi's workstation and activated the terminal. The glow from the screen created an island of light in the center of the room. *All right*, he thought. *Let's see what we can find.*

He downloaded Koyanagi's disc and went through each document, one by one. He wasn't sure what he was looking for. Evidence. Evidence of something, anything to prove that he was right. Or wrong. Unconsciously, his hand searched out a nonexistent shirt pocket, fumbling for a stick of gum. When he realized what he was doing, Singer grunted sour amusement. Jessie was right about his habits.

It was four-thirty before he finished reading. And there was nothing that he could find to prove Koyanagi's piracy. The altered structures (if they had been altered and were not simply errors) were on Koyanagi's disc as well as Patel's. Surely a saboteur would keep the original, correct copy.

Could I be wrong? But, no. Kal had been sure of himself. And deliberate sabotage would explain so much. All that overtime, and so little progress. Singer remembered thinking that not too long ago, when the money situation had just begun to reach critical. He glanced over his shoulder at his office window. He had stood by that window looking out at a beehive of activity: Kal contemplating his screen; Koyanagi copying discs; Jessie and Eamonn deep in conversation. And he had wondered then why they had been falling further and further behind their schedule.

Well, now he knew. Someone had been holding them back. Koyanagi, if only he could prove it.

Copying discs?

Singer sat rigidly in the chair. Koy-

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anagi had been running discs through his terminal. Then he had glanced up and had seen Singer watching and had started as if caught in the act.

In the act of what?

In the act of making unauthorized duplicates.

Of course! It had to be. Singer pulled on the drawers of the desk. Locked. They would not open. He yanked on them several times, hard enough to rattle the desk. Dammit, did he have a spare key? Every desk came from the furniture company with two sets of keys. Where was the second set?

He pushed himself away from Koyanagi's terminal and strode to his office. He flicked on the light. *I usually toss the spares in the bottom drawer.*

He opened the drawer and rummaged through it until he found a tangle of small keys that had migrated toward the back of the drawer through Brownian motion. He seized them and hurried back to Koyanagi's desk. He noticed he was breathing hard. Anxiety attack, he thought. I'm afraid of what I'll find. Or what I won't find.

The third key he tried fit. The drawers unlocked and he pulled them out one at a time and groped feverishly through them. His hand closed on a small case in the back of the bottom drawer and he paused. He pulled the case out. A minidisc holder. The discs inside were unlabelled. He picked one and inserted it in the terminal.

THIS DISC IS UNREADABLE. DO YOU WISH TO INITIALIZE IT?

Singer ejected that disc and tried another. It, too, was blank. So was the third. The fourth . . .

The remaining discs contained duplicates of the files. Not the regular backups that sat in their racks over the filing cabinets. These were secret duplicates, squirrelled away. He scanned for the folder he wanted and opened it.

Carefully, he studied the two structures that Kal had believed altered. He compared them to the copy that Kal had given him. He went down the chains, codon by codon, and . . . *there!* A thymine group at that address instead of an atropine. A double bond there instead of a single bond. Subtle differences. Easily unnoticed.

He sat in front of the terminal, staring at the evidence, an aching in his body, in his chest. Of all the sins, betrayal was the worst. Dante had found the deepest circle of Hell reserved for those who betrayed their benefactors.

How long he sat there, Singer did not know; but suddenly the overhead lights came on. He spun around in his chair and faced the entrance.

Jessie stood in the doorway, an astonished look on her face. She was wrapped in her housecoat. Her hair was rumpled and her face had the naked look of an habitual glasses-wearer without her spectacles. "What are you doing down here at this time of night?" she demanded. She took a step closer. "You're going through Masao's desk!"

"Yes."

"That's pretty shabby," she said distastefully. "Spying on your own people."

"Yes. But so is betrayal." He turned suddenly and shoved the open desk drawer closed with a violent motion. It bounced and opened again halfway. "Damn him."

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A worried look crossed Jessie's face. "That business of sabotage? You can't really know for certain. Kal may have been mistaken. Those might have been honest errors he found, not deliberate."

"No," Singer said wearily. "Kal was not mistaken. I found the original, correct versions. Your Jap friend had them hidden on a secret set of duplicate discs." He waved his hand at the case he had found, at the screen with the betraying diagrams, at Koyanagi's work station, at the heartless world in general.

Burton-Peeler stepped closer and squinted at the screen. "Oh." She studied the diagrams near-sightedly. "These are different from the ones in the regular files?"

"I just said that, didn't I?" Singer said irritably.

She pouted her lips. "Yes. Yes, you did." She was silent for a while. "This doesn't prove that Masao sabotaged the proteins. It only proves that they were sabotaged after he made these copies."

"Well? Why did he make the copies?"

"Backups?"

Singer said nothing, but pointed silently at the rows of backup discs atop the cabinets.

"He must have had a reason."

"Of course he had a reason!" Singer exploded. "Everyone has reasons! He was stealing the design and wanted to make sure that our copy wouldn't work. So he and São-fucking-Paulo would get a head start on us."

Burton-Peeler took a deep breath and let it out. She walked past him to Patel's terminal and ran her hand over the cabinet. "What will you do now?" she asked, her back to him.

Singer rubbed his hand across his brow and squeezed the bridge of his nose. "What else can I do? I'll have to fire the sonuvabitch."

"You can't do that, Charlie. I told you before. You need a majority of the shares to do that."

He looked at her, not believing what he had heard. "You and I have a majority," he said.

She stopped toying with Kalpit's terminal and wrapped her arms around herself. "Yes." She turned and faced him. "Is that what you want?"

"What I want?" He held empty hands out. "No, it's not what I want. I wanted Koyanagi's friendship."

"Intangibles? From you, Charlie?"

"Screw you." He had thought that finding proof of Koyanagi's piracy would make him feel better, would end the ache of uncertainty. But it hadn't. He felt angry and bitter.

She cocked her head and chewed on her lower lip. "You two were arguing all the time. About profits and altruism."

"So what? I don't require my friends to agree with everything I say. If Eamonn or Kal had been the saboteur, I would feel just as badly."

"What if it had been me, Charlie?"

He waved an arm. "You know, that's what hurts the most. The betrayal. You expect things like this from your enemies; but not from your friends. You don't know how much I was hoping to find a break-in by a hackercorp." His right hand was a fist. He sighed and rubbed it with with left. "Well, it's a dirty job . . ."

"Charlie, I can't let you do it."

"Eh? Do what?"

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"Fire Masao. Force him out."

"What are you talking about? You want to keep him with us? In spite of Royce and the government? In spite of *this?*" And again he waved at the screen. "No. Eamonn and Kal will vote him out, even if you don't help." He looked at her, trying to understand why she was opposing him again.

"No, Charlie. It was me."

"Who? What?" She wasn't making sense.

"I did it. I sabotaged those designs."

"You?" He blinked slowly. Then, more alertly: "*You?!*"

She pulled out Patel's chair and slowly sank into it. Singer watched dumbly, stricken speechless. Jessie studied her hands in her lab. The silence lengthened. "You." he finally managed to repeat.

She looked up, a defiant look on her face. "Yes, me! I did it. Every chance I had, I introduced tiny changes into the designs. Little incompatibilities. I deliberately suboptimized each of my assignments, so that none of the parts would quite fit together."

"And you always pointed out problems," Singer said. "Every time you opened your mouth, out came another stumbling block."

"Real problems," she told him, with just a touch of belligerency. "That needed real solutions."

"Solutions that could have been planned for if you had brought the problems up earlier. You held back. You held out."

"Some of it." She turned her gaze on her hands again. "Even I can't think of everything, Charlie. I brought up the fail safe issue as soon as I realized that some of my alterations had made the nanny potentially dangerous. I didn't want to hurt anybody."

"You didn't want to hurt anybody. Oh, great. Then this isn't blood on my shirt." He slapped his chest with his fist. "Why, Jessie? What on Earth was worth doing this to me? To the Lab?"

"Why?" She looked at him. "You still can't see it, can you? Even after Eamonn explained it to you."

"Eamonn? You mean—"

"Yes. If you give this nanny to people, they will become more careless about radiation. It's as simple as that. Government leaders, especially, will find the nuclear option to be more thinkable. Do you want that on your conscience?"

"Do I want what? You're being ridiculous!"

"Dammit, Charlie!" She stood up and glared at him. Patel's chair rolled across the carpeting, spun and fell. "Don't you ever call me ridiculous! You're so blinded by dollar signs that you can't see anything, any other ideal—"

"Oh, you're an idealist, are you? Well, idealists make me sick. You're so caught up with your lofty goals that you forget about people."

"What do you mean by that crack?"

"I mean you were perfectly willing to let Masao take the blame for the sabotage, weren't you?"

"I . . . No, I told you it was me. I told you I couldn't let you fire him."

"Sure. Tonight. When it came down to the wire, you couldn't go through with it. But why didn't you say anything earlier, in the car? *Why did you let me go on thinking it was Masao?*"

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"It . . ." She wrung her hands together. "It didn't seem as important as stopping a war."

"Stopping a war? Be realistic. Even if what you say is true, you're not talking about stopping a war. All you're talking about is an increase in a probability. From one chance in a trillon to two chances in a trillion."

"When the payoff is minus infinity, does it matter how long the odds are?"

"Any excess, if the cause is good? Where have we heard that before?" He stood abruptly and stalked to the door.

"You've heard nothing. Nothing at all."

"Don't talk to me." He held his hands out, as if to shield himself from her.

"Where are you going?"

"Out."

"In your pajamas?"

He said nothing for a moment; then he stamped up the stairs to the apartment, where he found a pair of jeans in the clothes hamper and pulled them on. He couldn't think. His mind was racing in circles, thinking the same thoughts over and over. He was tying his sneakers when Jessie finally appeared in the bedroom doorway. He concentrated on his laces.

"Are you coming back?"

He stopped tying, but wouldn't look at her. "Maybe." He resumed tying.

He finished, rose, and pushed his way past her. At the front door he heard her call him from the top of the stairs.

"Charlie?"

He froze with his hand on the knob. "Yeah?"

"Promise me one thing."

"What?"

"Promise me that you'll think about what I said. About how people will react. I mean, that you'll *really* think about it."

He yanked the door open and slammed it behind him.

XI

Singer returned to the Lab later that morning, his sweatshirt stained under the arms and his hair matted down with perspiration. His breath was ragged with exhaustion. He had spent the last three hours alternately walking and jogging the back streets of the township, being barked at by dogs, being paced for a short while by a police car. Running had become an end in itself. While he ran, there was nothing except the physical reality of feet slapping the paving; of the shocks running up his legs; of the air bellowing in and out of his lungs. He had rested for only a short while, on a stone bench in Roosevelt Park, staring sightlessly at the pond, unable to pull his thoughts together. He would be there still except that he had seen storm clouds gathering in the northeast.

Physical exhaustion had calmed him, at least to the extent that he could conjure up no feelings from the early morning argument. He paused in the doorway of the Lab and saw the others staring at him curiously. *I must reek*, he thought. He noticed Masao brush at his sharply creased trousers and finger the knot on his tie. Eamonn, whose work required him to get dirty from time to time, always dressed more casually than the others; but even he was staring at Singer with surprise.

Jessie walked by with a hardcopy in her hand. She paused when she saw

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Singer standing there. Her lips parted slightly, as if she were about to speak. Then her eyes hardened and she turned her back on him abruptly and walked away.

Singer stepped into the Lab and slammed the door hard behind him. Kalpit, engrossed in the display on his screen, jumped at the sound and turned around. Masao blinked with owl-wide eyes. No one spoke.

Singer strode past them with barely a glance. He ignored Jessie when he passed her workstation, and she ignored him. Part of him knew that this was not the way an argument should be handled. Let it all hang out. Wasn't that the advice everyone gave? Don't hold anything in. But he was afraid of what might happen if they did let loose. He was afraid that one of them would say something that could never be unsaid. And so it was safer to barricade himself behind his desk and dare the world to come to him.

He sat there, his two hands clasped together into a ball on the desktop. *How could she do this to me?* Didn't she realize that, with their financial situation as precarious as it was, sabotaging the project would ruin them? Didn't she care?

After a while he looked up and out the office window. The others were going about their tasks with the care of a squad of soldiers crossing a minefield. They could feel the tension, and no one wanted to be the spark that accidently ignited it. They spoke to each other; but lowly and briefly, and in whispers. And none of them looked at him or at Jessie, where she sat staring fixedly at her screen, her face set in the granite of righteousness.

No way out. He shook his head slowly. No way out. Jessie. Masao. Eamonn. Bitterly, he wondered what Kalpit was up to that he didn't know about. Jessie had been right. You don't sell out a friend. But Masao was pirating. And Jessie was sabotaging. So, who was selling out whom?

He put his face in his hands. *Oh, Jessie. What are we to do?*

A time went by, while Singer remained seated at his desk, thinking and feeling nothing. In every direction he looked, he saw nothing but wreckage. His thoughts, his feelings were numb.

Gradually, however, his strength returned and, with it, his anger. The anger built slowly, from a dull, red glow of hurt and resentment to a bright flame licking at the edges of his mind. One by one, he laid the sticks of memory on the fire. His hands slowly balled into fists on his desktop.

He glanced out the window again and saw Jessie talking with Eamonn. He remembered the Irishman's musings about— What had he called that spook? The Washer at the Ford. Memories of a nightmare tickled him. *Jessie must have put him up to it.* With her talk of nuclear war and atomic carelessness. She hadn't had the guts to come to him herself, so she had used Eamonn as her cat's paw. Dammit, he hated cowardice.

Jessie said something to Eamonn and it must have been funny, because he laughed. Somehow, that enraged him even further.

He shoved himself from his desk, rose, and threw the office door open.

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Everyone looked and froze; but he ignored them and stalked across the floor toward his wife and the machinist.

He stood before them silently, suddenly at a loss for words. he didn't know where to begin. He knew he must look angry, for Eamonn was staring at him with frightened eyes. Jessie looked him up and down.

"Don't you think you should shower and change, Charlie?"

He gave a spasmodic half turn toward her and his hand came up a fraction of an inch. "You can't brush everything off so glibly," he told her.

Eamonn began to ease away from them and Singer turned on him. "And you don't get off, either, Murchadha." He let his gaze slide from one to the other. "So, you put him up to it," he said to Jessie. "I should have known. Dammit. Why didn't you come to me first? Why did you have to hide your doubts; drag your heels; pump poor Eamonn here to bring them up to me?"

"Just a moment, Charlie—"

"And you," he turned to the nanomachinist. "Did you have to parrot everything Jessie told you? Can't you think for yourself? You and your Morrighan. Bulletproof vests."

Murchadha's face grew red. "Doctor Singer, I am not such a lackwit that I cannot see a plain possibility. Had you taken the time to reflect on it, you would have come to the same conclusion yourself."

"No, he wouldn't have, Eamonn," said Burton-Peeler with a sigh. "He can't see it even now. You've told him, and I've told him and he still thinks we're worried over nothing. And he can think of no more plausible explanation for why the two of us reached the same conclusion than to suppose that one of us coached the other."

"Aye," said Murchadha. "That *you* coached *me*." He looked at Singer with smoldering eyes. "I have not the wits for independent thought."

"That's why I didn't say anything to you," she said, turning to Singer. "Every word out of your mouth told me you weren't prepared to listen. The *only* thing about this project that meant anything to you was the money. You can't see past the dollars."

"And you can't see them at all. Or doesn't being poor worry you?"

"Charlie, we're a long way from being poor."

"Perhaps," said Murchadha, "if I am so poorly endowed with the powers of reason, I should seek employment elsewhere."

Singer looked at Murchadha. "Perhaps you should. Take your worries somewhere else."

"They are more than worries, Charlie," said Jessica. "They are moral issues."

"*Moral* issues? Then maybe you shouldn't dirty your hands on the project, either. Leave that to us sinners."

"Maybe I should."

"And making a profit is what business is all about, or haven't you heard? A company makes a profit or it dies."

"So. People need to eat, or they die. Does that make eating the sole purpose of life? I never said that profits didn't matter. I said that you saw *only* the profit. But what about the nuclear issue Eamonn and I raised? What about the social issue Masao raised? What about

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everything else in the world *besides* profit?''

''Please! What is going on here?''

Singer turned and saw Koyanagi and Patel. They were standing side by side, Patel with a bewildered look on his face; Koyanagi wringing first one hand, then the other. ''Why are you arguing?'' Singer had not realized how loud their voices had grown.

''Do you want to tell them?'' Singer crossed his arms and sepped aside.

Burton-Peeler stuck her chin out. ''Eamonn and I believe the nanny could be dangerous if it were released to the world.''

''What?'' Masao seemed confused. He looked from Peeler to Singer to Murchadha.

''Because it may encourage folk to carelessness around nuclear matters,'' said Murchadha. ''Meltdowns and heavy releases will become more probable; and thus in the long term, more frequent.''

''But,'' said Patel, ''the nanny will protect people. That is its purpose.''

''Aye, it will protect people; but what of the birds and the squirrels and the cattle and the trees?''

''Perhaps that lack of protection,'' said Singer drily, ''will encourage people to be *more* careful.''

''It's not symmetric, Charlie,'' Jessie told him. ''But the worst of it is,'' she continued to Patel and Koyanagi, ''is that the carelessness will extend to nuclear weapons. People, world leaders in particular, will consider them less dangerous than before; and, if less dangerous, then more likely to be used.''

''Surely, not!'' Koyanagi protested.

''It's a question of probabilities,'' Burton-Peeler insisted. ''What if just one ayatollah, or one caudillo believes it? How many is too many? Just tune in to the U.N. debates later this year, when all of the world's so-called leaders will be here, and you'll see what I mean.''

Patel looked thoughtful. ''There may be something in what you say.''

''No!'' That was Koyanagi. He seemed agitated, almost ready to burst into tears. ''It cannot be true! No one would behave so irresponsibly.''

''You tell 'em,'' said Singer. Koyanagi had a lot of nerve coming to *his* defense.

Jessie's mouth opened. ''Masao. Charlie's blind to anything but the bucks; but I would have thought that you would see the truth of it.''

Koyanagi said nothing, but shook his head slowly and firmly. ''I have greater faith in human nature than you.'' Singer almost choked to hear Koyanagi say that. Singer had placed some of his own faith in Koyanagi's nature.

''Of all the world's religions,'' said Murchadha, ''those that place their faith in human nature have the shakiest foundation.''

''Eamonn and Jessie told me they're quitting the project,'' said Singer. It was an overstatement. A provocation. He had deliberately phrased it so. He saw Jessie stiffen. ''That way,'' he finished, looking her straight in the eye, ''they won't share in the moral blame.''

''Charlie, it goes beyond that. Believing what I do, how can I let *you* work on the project?''

''Oh? How do you plan to stop me? More sabotage?''

''Sabotage?''

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Dead silence fell on the group. They looked at each other, at Burton-Peeler. Koyanagi was openly shocked. "Dr. Peeler sabotaged the project?" He stared at her as if he had never seen her before. Patel looked as if he were about to burst into tears. "It was she?" he asked.

"Yes, our illustrious vice president has been sabotaging the project. What do you think of that?" He crossed his arms once more over his chest.

"I was trying to delay the project — drag things out," she explained. "I hoped that you and the others would see sense. But only Eamonn did."

"But sabotage?" asked Patel. "Why did you never raise the issue openly?"

"Why, so Charlie could dismiss it out of hand?"

"It was not right," Murchadha said and Peeler flashed him an injured look. "'Tis one thing to argue against a course of action," he told her. "'Tis another to let down those depending on you. It wasn't honorable."

"Honor? We're talking about upsetting the nuclear stalemate, and you talk about honor?"

"What is life without honor?"

"What is honor without life?"

"So, Jessie," said Singer smugly. "How *do* you propose to stop us?"

"We'll vote the project down. You and Masao want to keep it going? Fine. Eamonn and I want it stopped. Between us, we control as many shares as you two."

Singer reflected that there was a fine irony in that the survival of the project now came down to an alliance between himself and the man he intended to force out. He turned to Patel. "Well, Kal? It's up to you."

Patel looked at the four of them and shook his head. He walked off a little distance and sagged against Murchadha's worktable. His hands pressed against the surface and he leaned on them, his back to the group. "Up to me?" he said. "Why should it be up to me? Who am I? All I want to do is design better molecules. I do not wish to be the center of attention. I do not wish to be the decision-maker."

"You can't help it, Kal," said Singer. "You're in center stage, whether you want it or not. You put yourself there when you came to me about the sabotage."

The microbiologist lifted his head and turned to them. He bit his lip. "I don't know. I see there may be a danger such as Jessica and Eamonn have pointed out; but I do not think closing our eyes will make it go away." He looked at Koyanagi. "Masao?"

The Niprazilian pulled himself up straight. "It is a task that must be done. I will stay on." Patel nodded.

"Then if Masao stays, I will stay."

Singer snorted. "Then goodbye. Because Koyanagi's not staying either."

"What?" Everyone but Jessie was startled.

"The government man," she said, "told Charlie that, unless he fired Masao, *the government would not honor* the contract."

Patel looked saddened. "But it was *not* Masao, after all, who was sabotaging the work."

"It had nothing to do with any sabotage," Peeler said. "The government just didn't like the slant of Masao's eyes."

"Ah, but you were willing to let me

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go on believing that Masao was the saboteur, weren't you? You didn't say anything at first, even though you knew better."

"You suspected *me* of the sabotage?" Koyanagi asked Patel. Patel looked miserable but said nothing.

"Sabotage was not Masao's intention," said Singer. "He was going to pirate the design. He was keeping secret duplicates of all of our work." Singer saw how Koyanagi jerked his head to look at his desk drawer.

"You searched through my desk." Koyanagi made it a statement, not a question.

"Piracy?" Patel shook his head. "No, I do not believe it."

Singer jerked his thumb. "Go ahead, ask him."

Koyanagi drew himself up. "That was improper, to search my desk like that."

"It was improper to steal our work."

"I . . . I was copying. But not for myself. For humanity—" Singer's laugh interrupted him but Koyanagi raised his voice. "For humanity, I say! So that the poor are as protected as the rich. So that the love of profits does not condemn the helpless."

"But theft?" asked Patel. "Masao, I had thought better of you."

Koyanagi looked at him in disdain. "You had thought me the saboteur."

Patel hung his head.

"Saboteur, thief; what difference?" said Murchadha. "Is one more honorable than the other?"

"I had good reasons for what I did."

Murchadha nodded at Burton-Peeler. "Aye, and so did she. And neither reason was good. As I said, what is life without honor? When the Green Knight comes, will you bare your neck?"

"But—"

Murchadha drew himself erect. In his eyes Singer thought he saw the righteous stubbornness of countless Irish heroes. "An opponents' motives seldom seem as right and pure as our own. My reasons justify my actions; but your reasons do not justify your actions. Sure, is not every pettiness built on good intentions?"

"Look," said Singer. "I was wrong about you, Eamonn. You're welcome to stay on. So are you, Kal. Neither of you did any harm. But you, Koyanagi-san, and you, Jessie . . ." He couldn't look either in the eye, so he chose to look at the nanolathe. "I'll have to ask you to . . . distance yourselves from the project."

"Just how far do you want me to distance myself, Charlie?"

Singer still would not look at her. "You be the judge."

"Doctor Singer," said Murchadha. "I don't know if I can stay. I never knew you had so low an opinion of me; and . . . and I still believe that the Washer is waiting for us at the river. And maybe *Magh Tuiredh* on the other side. I don't know that I can work on the project in good conscience any more." He scowled and stuffed his hands into his pockets. "I need to be thinking about it." He turned slowly and walked off. The others watched silently. When the Lab door closed softly behind him Singer sighed.

"It's just you and me, then," he told Patel.

Patel shook his head. "It is a good project. I do not agree with young Ea-

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monn, or with you, Jessica, but—" Again he shook his head. "There may be too much bad karma here. Friends have turned upon friends." He looked at Koyanagi, then at Burton-Peeler. "I know you each had your reasons; but you have hurt people."

"Idealists don't care who they hurt," Singer told him.

Patel looked at him. "Nor do mercenaries. You were prepared to find an excuse to fire Masao, weren't you? If not his piracy, you would have found another, less legitimate reason. And why? Simply to please the government and obtain their money." He held his hand up. "I know. I know. You had good reasons, too. Without the money, the Lab might not survive." He shook his head. "But I do not think this would be a pleasant place to work after this. What if Indians were next on the government's list?"

"You're an American," Singer told him.

Patel smiled wearily. "Tell that to the dot-buster gangs." He looked at his work station sadly. "Still, I will miss this place. I will miss the years we had together, before we discovered our true *atman*." He looked at Koyanagi. "And I will miss the years we might have had together." He held his hand out for a moment, then dropped it. "No," he said. "It would be hypocritical, would it not? Well, perhaps in another life."

And he, too, left.

Koyanagi shifted uncomfortably from foot to foot.

"What will you do now?" he asked.

"Do? What can I do? You'll have to go. I can't keep you around any more, can I?"

"I see."

Singer glanced at him. Masao's face was rigid and expressionless. The inscrutable Oriental. That was bullshit. There was pain written all over him.

"Don't let the doorknob," Singer said, "ream your ass on the way out."

Koyanagi flushed and bowed his head. "You do not understand my motives," he said and turned and walked away.

When Koyanagi was gone, a silence settled over the lab. Singer stood unmoving. Then he glanced over his shoulder where his wife sat on Eamonn's stool. "Well, you've got what you wanted," he said. "We're ruined."

"You did it to yourself, Charlie," she said wearily. "This was never what I wanted."

"Oh? What did you want, then?"

"I wanted you to see reason."

Singer grunted. "Your reasons."

She laughed sadly. "Now you know how he felt, don't you, Charlie?" She slid off the stool and shuffled toward the door. Singer felt fear in his stomach. He remembered their first day as lab partners in school; the dark times when he had failed and she stood with him. He remembered how they had created Plastiphage together; and EverKleen and AireFresh and all the others. The delight of discovery. Hugging each other; jumping up and down like giddy schoolkids. He wanted to shout, *don't go!* But he didn't want to give in to her, either.

"How who felt?" he asked her.

She looked around the empty laboratory. "Samson," she told him. "When he stood in the ruins of the temple."

Singer closed his eyes briefly. "If I'm

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Samson, then you must be Delilah. The woman he loved and who betrayed him.''

Jessie looked at him and worked her lips. She seemed about to say something, but then changed her mind. She shook her head and opened the door. ''Good-bye, Charlie,'' she said.

Then he was alone.

He looked about him, at the terminals and the equipment. The empty chairs. The hiss of the air conditioner sounded like the breakers on a midnight beach.

XII

His indecision lasted only until he heard the front door slam. Then he bolted from the lab after her. ''Jessie!'' He threw back the front door and raced across the broad, grass lawn that fronted the building. When he came to the street, he stopped and looked both ways. The black clouds he had seen earlier were boiling in from the northeast, and the trees and buildings had that ethereal appearance that marked the pause before a thunderstorm. He felt the hairs on his neck rise and somewhere far off lightning flashed.

He saw her at the end of the block, a specter turning left on Christie Street. He sprinted after her, his heart thudding. ''Wait!'' The upper branches of the trees thrashed as the front moved through; and he heard the distant rumble of thunder. ''Jessie, wait!''

When he reached the corner, he saw that she had stopped by the fence ringing the Edison Tower. The darkness of the storm had tripped the automatic switches and the giant lightbulb atop the Tower cast a brightness around her. She was leaning against the fence, with her fingers curled through the steel mesh. Singer caught up with her and took her by the arm.

''Jessie!''

She pulled her arm away from him. ''Don't touch me.''

''Jessie, I'm sorry.''

She turned her face away. ''Does this mean I'm not fired?''

''I can't fire you. You own 25 percent of my business.''

She shook the fence, hard. Waves of steel rippled and rattled down the line of posts. ''*Our* business, dammit! Ours, not yours. You can't make one of your stupid jokes out of this.''

''All right. Ours.''

''And Kalpit's and Eamonn's and Masao's. We were partners, not underlings.''

''I know that, Jess. I told Royce that myself.''

''But you didn't act it. Not on this project, anyway. It changed you.''

''I . . . was worried. It was a very expensive project. We were on the knife edge of profitability. It was twisting me up inside.'' Oddly, he realized that that knot was missing now. Now that his ruin was a fact, he could deal with it.

''Is that an excuse? I'm not stupid, Charlie. I know that the Lab needed money; but that gave you no right to do the things you did. You never closed your eyes and ears before. You were always willing to listen.''

''And is that your excuse?'' It was an automatic riposte. He had not intended to say it; or to say it quite so bluntly. ''Because you thought I wouldn't listen, you went behind my back.''

''Would you have listened?''

''I—'' He stopped. ''I don't know.''

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He shoved his hands in his pockets, turned, and leaned against the fence. The links pressed into his back. "I like to think I would have, in spite of everything. But that's not the point. I did what I thought I had to do. Maybe I was wrong. But you and Masao also did what you thought you had to do."

She turned her head slightly and the light from the tower illuminated her face in profile. It shone through the curled edges of her hair, and made a diamond sparkle down the curve of her cheek. "All right," she said. "I was wrong, too. Is that what you want to hear? You were wrong and I was wrong and Masao was wrong and now everything is just pralines and cream and we can all go back to the way things were."

"Can't we?"

"Charlie, sometimes you are the stupidest man I have ever known! Do you know that you have called me by my name more times in the last five minutes than you have in the last five months?"

"What?" Singer was puzzled by the irrelevancy of the remark. There was another crack and rumble; still distant, but closer than before. A car rolled down the street and its driver looked at them curiously.

"Never mind," she said. "It doesn't matter any more."

"Dammit, it does matter. Otherwise we wouldn't be standing here right now."

She must have heard something in his voice, because she turned at last and faced him full on. "Yes. You came after me. I . . . wondered if you would." She paused and walked a few steps away from the fence. "Charlie, I said that I could see your viewpoint. About the money. I can even empathize with it. Why can't you make the same effort to see my viewpoint?"

He started to remind her that he had good reasons for everything he had done. But wasn't that just the problem? Everyone had good reasons for what they did. He knew he was facing the most important crisis in his life. More important, perhaps, than even that October midnight. And the issue was not money; not who owned the Lab; not even the Washer at the Ford. It was Jessie and their life together. She was hard to live with. She was opinionated, assertive, and just plain ornery. She had shown just recently that she did not trust him. Yet, he realized, the one thing he did not want was to lose her.

He squatted and leaned his back against the chain-link fence. "All right," he said. "Explain it to me. I'll listen. I promise."

She walked slowly to one of the big elm trees that lined the street and ran her hand over the rough bark. Charlie waited patiently. Then she looked back at him. "Do you know anything about psychology, Charlie?"

"Sure. You pay a shrink sixty NewDs an hour to do what priests once did for free. To find out that you have a fixation because of some childhood trauma."

She gave him an odd look. "Yes. To find out that very thing. But that's beside the point. I asked you about psychology, not psychiatry. Psychology deals with behavior. Observable phenomena, not mental attitudes or beliefs." She pulled a small piece of bark off the tree. "Tell me. If we needed money as badly as you say, why didn't you rob a bank?"

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"Say what?"

"Why didn't you rob a bank? That's where they keep the money."

"Don't be silly."

She slapped the trunk with her hand. "I thought you said you would listen to what I had to say."

Singer took a long, deep breath and let it out slowly. "Yeah. I did. Do I do that often?"

"Too often, for someone as liberated as you are. I'll never mistake you for a Sawyerite, but in some ways that only makes it hurt more." She paused and flipped the piece of bark into the gathering gloom. Lightning flickered and washed everything of color. Singer thought that they should get indoors.

"So, why don't you rob banks?" she insisted.

Let her make her point her own way, he decided. "Because it's wrong."

"Who says?"

"Who says? God. The Law."

"So what?"

"So they put you in jail. Or in hell, depending on who catches you. It's not worth taking the chance. Not worth taking the chance," she repeated. "That's exactly right. Every act has benefits, but it also has costs. The probability of engaging in an action is proportional to the margin of profit. Lord, Charlie. This is your favorite language! Costs, benefits, profits. You don't rob banks because the probable profit is too small."

"Dammit, Jessie. You make people sound like rational robots! They aren't. If people were rational, we wouldn't be worried—"

"Wouldn't we?"

"—and I haven't avoided a life of crime because the cost/benefit ratio is too low. I don't rob banks because it's *wrong!*"

"So. If it's wrong because God said so, then isn't the absolute certainty of Divine Punishment part of your probable costs? Or if it's wrong because it harms the fabric of society, then isn't that part of it? The costs and benefits aren't money, but intangibles like time, energy, self-esteem, comradeship. Things that we balance in here." She thumped her breast.

"But what does all that have to do with the Washer at the Ford?" Lord, why was he using that nightmare image? Because Eamonn told a good story? Because the afternoon was dark and stormy, full of premonition? "You can't tell me there's a profit to be had in a nuclear war."

"No? How do you measure the profit to be had from the satisfaction of destroying your enemy, even if it brings the temple down around you? Blast it, Charlie, people vary. We're individuals, making individual assessments of probabilities. Who can say what looks like a reasonable chance to another person? People play slot machines, for God's sake. They buy lottery tickets. No matter where you draw the 'break-even' line there will always be some who fall on the other side of it."

Singer thought about that. "Ernie and Emily," he said.

"Who?"

"Nothing. It's just that I had the same kinds of thoughts a while back. No matter where you draw the line, there will always be some who fall on the other side of it. But that was a technical issue: biophysics and system analysis."

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"People are part of the system, too, Charlie. And operant conditioning is about as well founded in psychology as Mendel's laws are in genetics. There's nothing robotic about it. People generally make reasonable decisions—in the light of the data available to them. The difficulty comes in deciding what is 'reasonable.' "

"Isn't that always the difficulty?" Singer said. "Isn't that what just tore our team apart? Everybody being so damned reasonable." The whole behaviorist notion of motivation seemed simplistic to him. People were more complex than Jessie gave them credit for. Although . . . economics was also complex; yet the cost/benefit principle was an elegant simplicity lying at its heart. That the principle was more general than economics—that, in fact, economics was a "special case"—seemed attractive. Perhaps deceptively so.

"Still," he insisted, "You're talking about probabilities, not realities. That's why I couldn't buy the argument before."

"So. How do probabilities for individuals translate into determinism for populations? If the 'profit margin' of a behavior puts its probability at, oh . . . let's say 0.001 and there are three hundred million people in the country. Then we can predict that 300,000 people will choose the behavior and fall on the other side of that line."

"Plus or minus eleven hundred or so," he said, "assuming p was the same for all strata of the statistical universe. If not, it would depend on the prior distribution of—"

"Forget the technical details, Charlie. They're not important. The point is that an unpredictable probability for an individual becomes a predictable distribution for a mass of individuals. Statistical mechanics don't care whether the individuals are molecules or people. Now what do you suppose happens to p if you reduce the costs of the behavior?"

"Jessie, I'm not stupid either. More people will choose the behavior. Maybe twice as many. Maybe two in a trillion instead of in a trillion."

"*But it must increase*. Don't you see? By reducing the perceived penalty for nuclear war, our nanny will make it just a tiny bit more likely."

The trouble was, Singer realized, was that he *did* see it. Perhaps he had always seen it. He remembered the Green picketers that he and Royce had watched at the docks. He had assumed at the time that they were protesting the nanny itself. Plastiphage reduced the penalty for dumping garbage, at least plastic garbage. It was, in that sense, a license to pollute, and the Greens were less interested in cleaning up the environment than they were in not trashing it in the first place. They wanted to change human behavior, not accommodate it.

And he had read somewhere that the spills from the Arthur Kill landfill were becoming more frequent, not less; and that efforts to control them had been reduced. He had shaken his head sadly at the time at the foolishness of New York politicians; but it had never occurred to him that the nanny itself might have encouraged a 'why bother' attitude.

He looked at Jessie. Or did the argument seem so reasonable now only because he did not want to lose Jessie?

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When you *want* the answer, you don't question the argument. Good old Thucydides. Those Greeks were pretty smart boys. Only how could someone know whether his own convictions arose from reason or from desire?

No, dammit. Her argument *did* make sense. What was it Eamonn had said? People were people. They reacted to the facts as they saw them, not as Singer saw them. If people were all the same, there would be no problem. But they weren't. They were a wild statistical distribution of individuals. Ernies and Emilies. Stubborn and pliable. Thoughtful and impulsive. Prometheans and Luddites.

He should have known. He should have seen it himself. How long had manufacturers been plagued with customer misuse of their products? Card tables used as stepladders. Screwdrivers used as chisels. As long as there have been manufacturers and customers. It did no good to argue that people *shouldn't* do such things. It was a foregone conclusion that some percentage of them *would*. And the courts had ruled that manufacturers were liable for any "foreseeable" misuse.

So the basis for Jessie's concerns was firmly entrenched in case law. And probably statute law as well. Section 402A of the Third Restatement of Torts, or something like that. He wondered, if the rad nanny were to lead to a nuclear war, who would be around to bring suit.

How do individuals know whether their own convictions arise from reason or desire? They couldn't. But when different people reach similar convictions, and those convictions are tested rigorously, in laboratories or courtrooms, they achieve a kind of objectivity, an inter-subjectivity. It didn't matter whether Jessie's argument was rational or not. It was real, and that was all that mattered. A scientist learns nothing if he doesn't learn to deal with reality.

"What's wrong, Charlie?"

He yanked a tuft of grass from the ground and pulled it apart. "I'm afraid you may be right."

"Afraid?"

"Certainly, afraid. The fact that you're right doesn't mean that I'm wrong. If we scuttle this project, for whatever noble reasons, it still means the end of the Lab. Creditors aren't impressed by noble motives." He sighed and used the fence to pull himself erect. "It's been a hell of a day, and I haven't had any sleep."

"What will you do? About the project, I mean."

He looked at her. "There's not much I can do, is there? The Team is scattered. And, even if they weren't . . . I'd have to give the whole thing a serious second look." He turned and kicked at the chain-link fence. "Damn."

"You don't take failure very well, do you, Charlie?"

"Failure, is it? Was it a contest? Was one of us supposed to win?"

She shook her head. "I don't know. It doesn't feel like winning."

The storm broke then, and large raindrops pelted them with the force of small stones. Flowers of water blossomed on the concrete and asphalt. The rain came down like a waterfall and they were both drenched within seconds. There were more lightning flashes and Singer became suddenly aware of the tower and the trees around them. "Come

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on," he said, "we'd better run back to the Lab!"

Jessie pulled her sodden blouse away from her body. "Why bother running?" The rain running down her hair and face made her shine, as if she were sheathed in glass.

He took her by the arm. "Because I'm not Gene Kelly," he told her; and thought that it had been quite some time since they had laughed together, even if it was only for a moment.

XIII

All right. What are you waiting for?

Singer eyed the telephone, picked it up, hesitated, then re-hooked it. *I don't know.* He rose and walked to his office door and looked out. Kalpit's terminal was dark; Eamonn's vats, empty. Overhead, he could hear Jessie's footsteps criss-crossing the apartment. The muffled thunder of the storm accentuated the emptiness. Quietly, he shut the office door.

Damn fool thing. Behavioral psychology? Why couldn't they argue over sex, like normal people? He pulled his robe together and listened to the rumble of thunder as it shook the walls. At least he was dry. Snug as a bug. He picked up his cup of steaming coffee and sipped from it.

Everybody has reasons for what they do. Everyone, in his own eyes, is reasonable. And what did that mean? When others behaved differently, then they must be unreasonable. Never mind that they might have reasons of their own.

Reasons of their own. Even when others behaved the same way, when they seemed to have the same goals, they still might have reasons of their own. He returned to his desk and, before he could change his mind again, grabbed the phone and punched in the eleven numbers and waited.

"Royce here."

"Yes, John," he pumped his voice full of hearty enthusiasm. "This is Charles Singer at the Lab. I'm glad I caught you still in."

"The work is never done."

"Isn't that the truth. Look, the reason I called. We've got a problem."

"What is it? Anything I can help with?"

"I don't know." He hesitated. As far as he knew, Royce had always played square with him. If the government man had been a son of a bitch, this would be a lot easier. Well, one more betrayal to add to his list. "Look, do you mind if I ask you a policy question?"

"That depends." Royce's voice was guarded. "I may not answer."

"Fair enough." Singer took a deep breath and put as much worldly-wise cynicism as he could into his voice. "I've been thinking. When you said the government would handle distribution of the nanomachine, you didn't mean you were going to give it to everyone in the country, did you? That wouldn't be very smart."

"Is that what you thought?" Royce sounded surprised. "Oh, no. Not at all. You can rest easy on that score. This is all *very* hush-hush. Why do you think we were so insistent on secrecy?"

Singer's knuckles stood out white where he held the phone. *What in bloody hell does the government get?* It gets to sit on the secret. "It wouldn't do to have everyone know about it," he allowed.

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"Certainly not. Half the advantage of having an edge is when the other side doesn't know you have it."

"And this would be a considerable edge."

"I can see you think strategically, Charles. You're right. If, God forbid, nuclear weapons are ever used on the battlefield, our forces would be able to move directly through the interdicted zones. Catch the enemy flat-footed. Nuclear war isn't something any of us want to see; but as long as the possibility exists, it would be criminal—treasonous—not to seize every possible advantage. I know it's fashionable these days not to give any thought to Armageddon. To pretend as if there is no danger. But that's our job. Thinking the unthinkable, so people can go on pretending. The more of an edge we have, the safer those folks will be."

"You will stockpile them for civilian casualties, though. In all the big cities. The nannies, I mean. If there's ever an . . . an exchange—"

Royce interrupted him. "Yes, and near all the other target areas. Europe, too. Don't worry, the logistics have all been worked out. If the balloon ever does go up, we'll get your drug—" He chuckled. "I mean your device—to the people who need it. There won't be any point to secrecy after the first attack. You needn't worry about that end of it. Just get the bugs out of your bugs."

Singer looked out his office window at the empty workstations. He could see Patel and Koyanagi in his mind's eye: Masao pointing to something on the screen; Kalpit nodding vigorously. He remembered how Masao had argued with him about profits and altruism. *Are profits so important compared to the benefits this machine could bestow on humanity?* He thought of the cosmonauts and space station workers. Few of them were Americans. There'd be no nannies stockpiled for them. Royce's loyalties might extend well beyond Number One; but they did not extend farther than the nearest border.

Poor Masao. But the altruists always lost in the end. Nice guys finished last. Wasn't that the way the world worked? Words of wisdom from a baseball coach. When it came to insight, Durocher was right up there with Thucydides.

So, it looked like Nemhain was going to take in laundry, after all. Hell, she could set up a goddamn laundromat. If a man as decent and well-intentioned as John Royce could be led astray, what hope was there for the others? For the crazed, or the ambitious? New technologies were ink blots. People saw in them what they wanted to see. Illusions. And, who could say? Maybe those who saw only an ink blot were the most deluded of all.

All right, Charlie, he asked himself. *What can you do about it?* He would have to kill the project. No rad nanny until humanity grows up and is ready for it. And too bad, John Royce, Masao Koyanagi, and Charles Singer. Disappointment and frustration for each. No secret weapon; no universal benefit; no profit. (Damn! He even sounded shallow to himself. No profit? At least Royce and Koyanagi had noble, if incompatible, intentions.)

Disappointment was a bitter herb; but he could drink his hemlock and smile.

Jessie wins.

And he had only to form the thought

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to wonder about it. Win? Was it a game? Did everyone else have to lose? No, we all win. We banish the Washer from the Ford.

But how do I kill the project at this stage? Even if SingerLabs is dead in the water, Royce could move the project to another company. The nanny would eventually be produced, even if they were out of the picture. *I'll have to set this up carefully.*

"Speaking of bugs, John," he said. "We've run into quite a few lately."

"Don't worry, you'll work them out. I have faith in you."

"I'm glad to hear that. But I think you should be prepared, just in case . . ."

"In case what?"

"In case the nanny may not be possible, after all."

"What do you mean, not possible? You mean in case you can't do it? We can always line up—"

"No, I mean, in case it can't be done at all. Period. Not just beyond the current state of the art, or beyond the abilities of my staff; but physically impossible. Our initial protocols didn't look too good."

"That doesn't sound right. Not after all those glowing weekly reports you've been handing in. And which I've been passing on to my bosses," he added pointedly. "Look, are you trying to send me a message? I told you, the money would become available as soon as you got rid of the Brass Jap."

And that was really going too far. "I don't send subtle messages, John. And there's no reason to be disrespectful of Dr. Koyanagi. He's a brilliant scientist. he's as responsible as anyone for bringing this project as far as it's gone. You can't hold him to blame for his government's unfortunate behavior."

For his own behavior, yes. Very much to blame. But Singer wondered to what extent he had forced Koyanagi into choosing piracy by his own rigid attitude. What if he had remained open? Would Masao and Jessie have come to him instead of working behind his back? Maybe. Maybe not. But they would have lost a rationalization for doing so.

Royce grunted. "You're right, Charles, and I apologize. It isn't fair. But we've all had to do things we've hated at one time or another."

Yes, thought Singer. *And once we have, there's no turning back.* It changes you, doing things you hate, no matter how you rationalize it or try to justify it to yourself. From his tone, Singer judged that Royce had made his own choice a long time ago. He wondered what it had been, and how the man had felt afterwards.

I guess I'll know soon enough how it feels.

"Feelings are running pretty high against the Co-Dominium," Royce continued, "and Japanese Brazilians are getting the worst of it. What I told you earlier still goes. Twenty years from now, we and Brazil may be the closest of allies; but right now, having your friend on the staff can torpedo this whole thing. If it were just me, I wouldn't care; but the damned subcommittee is still sitting on final approval. You know what politicians are like. They follow the polls like they were rings in their noses. If only we had a leader with backbone and moral prin-

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ciples, like . . . Well, you didn't call to hear me gripe."

Oddly, Singer realized that Royce was asking for Singer's forgiveness. One of Royce's most disturbing traits was his wholehearted sincerity. *He's in the wrong line of work for that.* Still, it was important to realize that people who opposed you could believe sincerely in what they did. He had had his nose rubbed in that lesson.

"*Absolvo te, filio meo,*" he said.

"What?"

"Nothing. I'll talk to Koyanagi tonight."

After he had hung up, Singer spent some time staring at the phone. Royce thought the nanny would give the country an edge. It probably would. But the problem with edges was that it was too easy to topple off them.

The trick was going to be to convince Royce that no radiation nanny was possible. To convince him so thoroughly that he would not try to keep the project going by shifting it to another company. Maybe he and Jessie could work out a convincing proof. Perhaps a dramatic failure. It would be for the greater good. *Greater love hath no man.* A dramatic failure? He felt a tingle move through his arms.

He sensed motion in the doorway and looked up. A rain-drenched figure stood there and his heart gave a sudden leap. Fear. A break-in? It took him a moment to recognize Masao Koyanagi. The man's clothing was sodden and wrinkled; his hair disarrayed. There was nothing left of the dandy he had known.

Drowned rat, he thought, and immediately regretted the thought. Not a rat. Not really. Not by his own lights. Still, what he had done had hurt. A lesser betrayal than Jessie's, but a betrayal nonetheless.

Masao entered the office and slumped in Singer's visitor chair. He wouldn't meet Singer's eyes.

"Well?" said Singer. He kept his voice carefully neutral, neither hostile nor welcoming.

"I—came to return my keys." He stretched out his hand and dropped a key ring on the desk. Singer looked at the keys, but didn't touch them.

"Is that all?"

"It . . . Yes. That is all." Koyanagi started to rise and Singer grimaced.

"Oh, sit down. It's raining cats and hounds out there. You didn't walk back through that kind of weather just to return my keys. Your keys."

"No."

"And I'm not going to let you sit there sopping wet. You're still covered by our group medical and if you catch pneumonia, I'll have to pay."

He meant it as a joke, to break the ice that had formed between them; but he saw immediately that it had gone flat. "Oh, dammit. I didn't mean that the way it sounded, Masao. Give me a second." He picked up the phone and touched the sensor that buzzed the apartment. He waited a few moments.

"Jessie? We have a guest down here who needs to dry off. Are you decent? No? Well, you don't look any worse than he does. . . . Masao, that's who. Sure." He covered the mouthpiece and looked at Masao. "You know I bought several bottles of *cachaça* after you came here and you're the only one who drinks the damn stuff, so Jessie says you have to come upstairs and warm up."

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Singer stood by the large front window, nursing his coffee. Across the street, the Edison Tower rose 131 feet into the sky. Singer paused and studied it. Not a very big monument, he thought, for the man who had single-handedly created the Twentieth Century. He wondered what Edison himself would have created if he had designed his own monument.

Probably nothing, he decided. Edison had been notoriously practical. He would have used the money to finance a new invention.

He turned and faced Masao and Jessie. They were sitting in separate chairs, trying not to look at each other. Masao was dressed in some of Singer's clothes, which did not fit him at all; and Singer wondered momentarily whether the man was as embarrassed by the baggy shirt and trousers as he was by everything else that had happened that day.

"Storm's over," Singer announced. The rain storm, at least. He looked past them, to the far side of the room. The front room ran the full width of the apartment. At the other end, another window opened on the tops of the trees that surrounded the property. Between their waving branches he caught glimpses of the brightly burning windows of the office towers on the far side of the railroad tracks. There was an extensive office park there; a luxury hotel. *I'm still on the 'wrong side of the tracks,'* he thought.

He drifted across the room to the other window and stood there, studying the lights and the silhouettes of the branches.

"Well?" said Jessie. "Isn't anyone going to say anything?" Singer turned and looked at her. "What is this, a wake?" she said.

"Yes," said Singer, and he saw her wince. *She doesn't like it any better than I do.* He twisted his hand, clenching and unclenching it, wishing for a stick of gum. "But, what the hell, it doesn't have to be a double funeral."

They both looked at him questioningly, and he scowled and added, "I'd rather bury a company than a friendship."

Koyanagi sucked in his breath. He shot from his chair and strode to Singer and embraced him. "Hey," said Singer. "I thought you people went in for polite bows."

Masao released him. "You forgot, I am a Brazilian. My parents emigrated before I was born."

"Yes, I know," Singer told him, disengaging himself from the *abraço*. "I did some checking up on you a while back."

"Ah?"

"Yes. Your grandparents were killed at Nagasaki, weren't they?"

Koyanagi hesitated, then nodded. "*Sim, senhor*. They lived beyond the blast zone; but they died later, from radiation-induced cancer. I do not like to speak of it."

"That was your purpose all along, wasn't it? The radiation nanny. You didn't care about fame at all. You wanted to make it up to your grandparents by giving everyone fallout protection. The power plant and space potential, was just to get me interested. You were going to pirate the design, once we'd helped you build it, and give it away for

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free." There was no one more ruthless, he reflected, than an altruist.

Koyanagi bowed and sucked in his breath. "I regret the miserable deception. But some needs go beyond price."

Singer swatted the air. "Don't apologize, dammit. Never apologize for doing what you think is right."

Koyanagi said, "That was why Dr. Pee— Why Jessie's arguments bothered me so. Perhaps more so than her actions. I wanted to protect people; and she was telling me that instead I was endangering them."

"And next to Charlie, you were my biggest obstacle."

They turned and looked at her. She was hunched over in the sofa, a thick mug of hot chocolate in her hands. She was staring into the chocolate. "You both wanted to build the nanny," she said to the room. "For different reasons, maybe; but you both wanted to build something that I saw mustn't be built." She looked at them. "I've been asking myself why I was so ready to let Masao take the blame for the sabotage."

"Oh, we're a fine crew, aren't we?" said Singer. "Let's invite John Royce over and we'll all party." He told them what Royce had planned to do.

Koyanagi sank slowly into a chair. "Classified? Top secret?"

"And what did you tell him, Charlie?" she asked.

"What do you think I told him?" he challenged her.

Koyanagi, who had been about to say something, looked back and forth and held his tongue.

Jessica parted her lips, paused, and studied him with narrowed eyes. "Yesterday, I would have said that you didn't care. That all that mattered to you was that you got paid for the job, and if the government wanted to stockpile the nanny in secret, that was their business."

Her words were like slaps, and he flinched from them. Was that really how she saw him? Did he really seem so shallow? Dammit, after all these years, she should know him better than that. Or maybe he did keep himself too close, never opening up to anyone else. Perhaps, after all these years, I should know myself better. He looked her in the eye. "And today?" he asked.

"Today?" She seemed unsure. "Today, I don't know."

"When I talked to Royce," Singer said, "I saw how neatly his intentions fit your argument. I mean the part about how the nanny would be used by society."

Masao sighed. "I do not want that to be so. It means the end of a dream that I have held for as long as I can remember." He clenched a fist. "Yet, my feelings on this matter are so intense and personal that I wonder if I can see the argument clearly."

"You and me both," grunted Singer. "But, if we make people radiation resistant, we reduce the penalties for wrong decisions. It's that simple. We make nuclear war just a little more thinkable."

"Just a little."

Singer grinned at Masao's irony. "Yes. It's all a matter of what one is used to, I supose. Why twenty or thirty megadeaths should be any more thinkable than seventy or eighty, I don't know."

"Will you stop the project, then?"

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There was a rumble behind them, heard faintly through the window. Singer turned and watched as a railroad train crossed his field of view. It shot from left to right, appearing in fragments between the waving branches. The rhythmic clatter of the wheels sounded far away and the brightly lit windows ran together in a blur. Sparks leapt from the overhead wires. It was an Amtrak train on its way to Philadelphia. The whistle blew and the sound floated back to them. Singer sighed.

"That's a lonely sound," he commented. "What is it about trains in the night time that sounds so damned lonely? You know, I used to lie awake nights when I was a kid, shivering and hungry in my bed, listening to them. The train whistles. It sounds melodramatic. Hell, it *was* melodramatic. I was a stereotype out of some damned Southern gothic novel. I would squeeze my eyes tight and wish for one of those trains to come and take me away from those Kentucky hills. One day, one did; and I left all that misery behind me. I left it behind," he repeated. "Maybe a part of me never realized that." He shook himself and walked slowly to the sofa. Sometimes, he thought, psychotherapy could be too damned expensive.

"It was a fool idea anyway," Singer told Koyanagi after he had sat down. "People just wouldn't believe you. Immunity from radiation, and a Jap is *giving* it away? Long before you'd convinced anyone you were on the level, you'd be in jail for fraud."

"But I could prove—"

"Do you think it matters what you could prove? The last headline anyone would see would be the one trumpeting your arrest. Jimmy and Jane Public saved from another quack. The truth never overtakes life."

"But, you will see the project through, Doctor Singer-sama? You will market it. You will not allow Mr. Murchadha and Dr. Peeler to dissuade you?"

Singer shook his head. "How can I finish it? Jessie and Eamonn won't help and you can't. We'd need the government money and your talents and we can't have both. And even with the government money . . . I don't know if we should."

"With their talk of increased risks?" Masao ran a hand through his hair. "I spent all day today thinking it through. Oh, not that Dr. Peeler was wrong. She wasn't, but one may be perfectly correct and still delude oneself. Wearing shoes makes people more careless where they step, but that is no reason for everyone to go barefoot."

Jessie raised her head and scowled at him. "This is a little more serious than ringworm," she said.

"She's right," said Singer.

Koyanagi made a sour face. "All this worry," he grumbled, "over such a slim chance."

Singer spread his hands. "Yes, all this trouble. But not everyone evaluates things the way we would and wishing won't make it so. People are part of the system, and an engineer works with parts and materials as they really are, and not as he wishes they were. And, as Jessie said to me the other day, when the payoff is minus infinity, how slim of a chance will you take? Look. Suppose I make you an offer. I'll roll four dice. If the total is five or more, I'll pay

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you a million dollars. But if it's a four, I get to poke your eyes out with a stick."

Koyanagi blinked and his hands jerked toward his eyes. Jessie winced.

"The probability of rolling four ones is only 1 in 1,300," said Koyanagi slowly.

"Actually, it's 1 in 1,296," Singer told him. "That's 1,295 chances of getting a million dollars versus only one chance of losing your eyesight. Does that mean you'll take the bet?"

The biophysicist shuddered. "No."

"That's right. Neither would I. For some things, probabilities don't matter. That's the issue I couldn't see earlier. We can't compute the rational choice. Or rather, the rational choice means foregoing the bet entirely. If you don't bet, you don't risk your eyes. You also don't get a chance at the million dollars; but you didn't have the million dollars to begin with, so you haven't really lost anything."

He sighed and pushed his hands into his pockets. "I don't like it, either, Masao. I'll proably . . . *We'll* probably lose the Lab over it. But, it's the only rational choice we have. It means forgoing the benefits, the radiation resistance; but we don't have those benefits now, so we aren't losing anything. The question is, can we scuttle the project in such a way that no one else will carry on? Remember, Royce and his committee already know what we're doing."

Koyanagi clasped his hands in front of him and looked at their faces. He seemed close to pleading. Singer hated to see people beg. "No," said Masao. "You cannot do it. I mean that literally. You *cannot* do it. We cannot 'forgo the bet,' as you said. The dice will be rolled. You see, Mother Nature is a blabbermouth."

Singer felt the shock like a slap across the face. He closed his eyes tight.

"Nature keeps no secrets," Koyanagi amplified. "You may fool Mr. Royce, perhaps for quite some time; but eventually others will learn what we have learned. Royce will not need to tell anyone. I was not the only researcher studying *M. radiodurans*. Do you suppose I will be the only one to wonder at its powers?"

Thoughts tumbled chaotically in Singer's head. *The genie is dangerous*, he realized. *But he's already out of the bottle*. We daren't go forward; and we cannot go back. The nanny will be built, but we mustn't build it. No way out. No solution. There had to be a solution. His soul rebelled against the notion that there may not always be solutions.

He rose from the chair and stood by the front window again. Edison's tower. It had always inspired him before. Edison, his patron saint. Saint Thomas. Thomas the Doubter. *Unless I put my fingers in the nailholes* . . . Singer had always thought of the Apostle Thomas as the patron saint of science. The other apostles *believed;* but Thomas *knew*.

But Edison had never had to deal with this sort of problem. How could society misuse light bulbs or phonographs? He wondered if modern popular music constituted misuse of the phonograph. Motion pictures. Motion pictures had taken families out of their homes for entertainment. They had initiated the long, slow breakdown of the family, displacing the hearth as the center of people's lives.

Technological change. Social con-

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sequences. The industrial revolution had killed slavery. The home appliance had made women's lib possible. That photograph of the Earth taken from the Moon. . . . Would environmentalism have grown as dramatically without that galvanizing picture? He wondered if there had ever been a social change, good or bad, that was not the spin-off of technology.

Pieces began to fall into place. Fragments began to coalesce. He began to see it. Not a solution, but the way toward a solution. He turned from the window.

"We'll build it," he said.

"No!" said Jessie, and she half rose from her chair.

"Jess, if it can be done, someone will discover how to do it," he told her bluntly.

"And if someone's going to make money on it," she said bitterly, "it might as well be us?"

"Well, why not? But that's not what I meant. I meant that it will be done by people who haven't thought through the implications as thoroughly as we have. I think I see a way out. I'm not sure. I need time to reflect."

"What about Masao?" she asked. "You'll need the government's money and Masao's talents, you said. And you can't have both."

Masao pursed his lips. "Perhaps I can help secretly?"

"No," said Singer. "We can't risk having Royce find out."

Masao nodded. He walked slowly to the back window and stared at the trees. He gripped his hands behind his back, squeezing first one, then the other. Singer and Peeler watched him. After a while, he took in a long, slow breath and let it out. "I could defect," he said.

"Defect," said Singer. He looked at Jessie then at Masao's back.

Koyanagi turned. "Yes. Defect. I could make speeches, if your John Royce wishes me to. I could denounce the Co-Dominium. His senator may appreciate a defector even more so than a native-born American."

Singer frowned and nodded. "It may work," he said. "It just might work. We'll run it through Royce tomorrow."

Jessie looked at Masao. "You could never go back, then. After defecting and making such speeches. Can you bear that? Never to see your home again?"

Koyanagi shrugged. "I will miss São Paulo and the rain forest and *Carnaval*. But this work comes first. Perhaps someday, when the word leaks out about what we have done, I will be able to go back."

"And what about me, Charlie? And Eamonn? All you've said so far is that, if the dice will roll anyway, we might as well place our bets. But it's still an irrational bet! You were bloody well convinced yourself, Charlie. Then you flip-flopped back. What changed your mind?"

"We're going to load the dice," Singer said carefully.

A frown creased her brows and she cocked her head. "Are you going to let us in on it? Or is this more of Charlie Singer, the Lone Ranger?"

He shook his head. "Not yet; because it's not clear in my own mind yet. Besides, Eamonn and Kal should be here, too. I'm going to call a meeting tonight to discuss it. No, it's too late and there's some reading I need to do. Tomorrow.

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A lunch meeting.'' He rubbed his hands together, thinking furiously.

Koyanagi raised his eyebrows. ''Load the dice?''

''Yes.'' Singer reviewed his plan mentally. It would scatter the Team, he realized. But it was necessary. ''Yes,'' he repeated. ''We need to reformulate our aerosol.''

He saw the most bewildered looks he had ever seen on a pair of human faces.

Singer cut his steak carefully into strips, listening to the strained conversation around him, but maintaining his own silence. Everyone was uneasy with everyone else. Jessie, the saboteur. Masao, the pirate. Charlie, who was ready to sell out his friend for government money. Kalpit and Eamonn, playing the roles of peacemakers. Blessed are the peacemakers, he thought sourly, for they shall be mowed down in the crossfire. He wondered if there were any two people at the table who had not offended each other.

He speared a strip of steak on his fork and dipped it in the marinade. They didn't call it teriyaki anymore. It had a good American name now. He had forgotten what it was. *Liberty cabbage*, he thought.

They were eating in the banquet room of the Steak and Ale on Route One, the room the restaurant used for parties and meetings. He had had Patel make the reservations from a public phone booth using a phony name. He had made sure the room had no outside windows. There were microphones, he knew, that could read the vibrations of a window pane and translate them back into words. Unnecessary precautions, perhaps. There was no reason to suppose they were under surveillance. Still, it was the nature of the beast to be paranoid.

When the waiter brought desserts and coffee, Singer told him they were about to start their meeting and did not want to be interrupted. He paid the bill and added a generous tip. The waiter did some mental arithmetic and he grinned and nodded. ''No interruptions,'' he agreed.

Burton-Peeler watched the waiter leave. ''All right, Charlie,'' she said, turning back. ''What's this all about?'' She stared at him, daring him to say something she didn't like. The other waited, puzzled but uncomplaining.

''Yes,'' said Masao. ''What is your plan?''

''Well, first off, we need an antidote—''

Koyanagi blinked. ''An antidote?'' The others' comments were lost in a babble. Singer shushed them.

''Next, we have to change some of the molecular structures—''

''The structures?''

''Which ones?''

''—and, of course, redesign Aire Fresh.''

Now he had complete silence. They all looked at one another, then at Singer. Finally, Jessie spoke.

''All right, Charlie. It worked. You've got our attention. Either you know something you haven't told us yet; or you've gone completely around the bend.'' Singer saw in her eyes that she wasn't entirely sure which it was.

He leaned forward, putting his arms on the table and clasping his hands. ''Look, what is it about this project that's bothering us? Some reasonably

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foreseeable consequences. Especially the one that Eamonn and Jessie pointed out to us." He paused a moment before continuing. "The more I thought about it, the more I realized that every technological change is also a cultural change."

"Everyone knows that, Charlie," said his wife.

"So? Then why don't we act as if we did? It's become a cliché to talk about the social consequences of technology; yet do we really take them into consideration? I'm not talking about those circuses they hold in Washington, where some official panel takes 'testimony' from 'witnesses' so everyone can ride their favorite political hobby horses. Hell, everybody knows what the testimonies are going to be before anyone so much as opens a mouth. The so-called 'findings' are geared toward ideology and the polls not toward serious extrapolation of consequences."

He paused and started to reach for his gum. Then he remembered that he had thrown it out. Bad habit, anyway. "Let me give you a small-scale example," he said. "A company once decided to expand its chemical laboratory. They needed more room, and they could prove it: with layout studies and space planning and the testimony of the chemists. It was a safety issue, too. You certaintly don't want chemists bumping into each other and dropping things. So what could they do?"

"Expand the laboratory," said Patel. He looked puzzled.

Singer smiled. "And that's exactly what they did. But there were social consequences: the larger lab building encroached on the parking lot, eliminating spaces. This threw more parking onto the already congested city streets. Workers had to leave for work earlier to find parking, disrupting routines at home. Who would drive the kids to school? Old car pools broke up and new ones formed, and with them, friendships. The ripples spread steadily outward. Who knows if they've damped out even today."

"How many people died, Charlie?" his wife asked sarcastically.

"Some," he answered. "Perturb the normal traffic pattern and you always get an increase in accidents." The others at the table stared at him thoughtfully. "It's all a question," he concluded, "of extending our fault tree into sociological areas; of not stopping when the technical issues have been dealt with."

"That's what I tried to do," Jessie protested. "Given human nature, it was possible to foresee how the nanny would be misused by managers and politicians."

"Yes," said Singer judiciously. "And Eamonn reached the same conclusion. You tried to broach the subject with me once or twice, didn't you?" he told her. "Looking back, I think I can see when. But you backed off when you saw that I wasn't even willing to consider the possibility. I'm sorry for that, and I apologize here and now to you and to the rest of you. This whole shindig was my fault. I didn't study my Thucydides." He saw how that remark puzzled everyone except Eamonn. "I thought that because I wanted *one* outcome of the nanny, that there weren't—that there *couldn't* be any other, less pleasant outcomes." He smiled at them to show how contrite he was.

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"But!" And now he stabbed a finger at Jessie and at Eamonn. "You two were guilty of the same sin. You thought that because you could foresee a single, bad consequence, that none of the good consequences mattered." He repeated Masao's analogy with shoes and going barefoot.

Peeler shook her head. "No, Charlie. It's not the same thing, at all. As I said earlier, being more careless about where you step simply isn't in the same league with being more careless with nuclear piles or weapons."

"Yes it is," he answered, "because they both deal with human psychology. Look, I've spent the day reading anthropology. It's pretty soft stuff. Anthropologists generally 'discover' exactly what they set out to discover—real science often takes its practitioners by surprise—but there is a core of basic principles that has been pretty well established. One is that every society has a pattern of culture—'rules of the road.' The major benefit of that pattern is its predictability. People know how they are expected to behave, whether they are bankers, burglars or revolutionaries. The underworld has its pattern of culture; so does Wall Street."

"Aye, the same one," said Murchadha.

"That's not the issue," Singer told him. "No matter what the pattern is, change—*any* change—is a threat. It breeds uncertainty. That's why people often resist changes that are clearly beneficial."

"I once told my superior at São Paulo," Koyanagi reflected, "that I had identified a simple process improvement that would save the company seven million novocruzeiros. He rejected it. He felt that having overlooked such an improvement for so many years would make him look foolish to his superiors."

"I once read of a tribe in South America," said Patel, "that was suffering from a diet deficiency. Their traditional diet was lacking in some amino acid. Or perhaps a vitamin? Well, no matter. The agronomists studied their situation and recommended they grow—I think it was soybeans. But the Indians refused and went on suffering."

"Exactly," said Singer. "I don't know the example, but I can guess why it happened. The tribe's resistance made no sense to the agronomists—the technological change was clearly beneficial. But the technological change was not the stumbling block. The cultural change was. Everyone in the tribe wanted to know, on some subconscious level, how the change would affect his place in society. Accepting the agronomists' advice would, for example, undermine the status of the elders as the local agricultural experts. And they were right, too. You can never change just one thing. Start growing soybeans, and who knows what will happen next? Revolution and anarchy." He spread his hands. "And before you go on thinking that that sort of thing only happens in primitive societies, let me give you another example that I know of, because an uncle of mine told me about it. The foundry he worked in was losing quite a few work hours to foot injuries. You lug a lot of heavy stuff around and some of it's going to get dropped on toes. So the company implemented a safety shoe program.

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They provided the workers with steel-reinforced boots." He paused and waited.

"Makes sense," said Murchadha cautiously.

Singer grinned. "You don't sound too sure, son."

"I'm waiting for the other shoe to drop."

Everyone moaned and Singer laughed. Some of the tension lifted and Singer made a note never to underestimate Eamonn's savvy again. "Yes," he said. "There was a catch. The boots were clearly beneficial, but the workers resisted. They wore them only under heavy supervisory pressure. Why? *Because their wives didn't like the shoes.* The shoes were heavy, unwieldy; and they marked the husbands as low-caste, blue-collar, factory workers. In my uncle's day, those were important considerations." He let his gaze circle the table. "As scientists and engineers, we have to do more than just shake our heads and say that the wives were being illogical—"

"Wait a minute," said Jessica, interrupting. "The answer is obvious. Redesign the shoe so it looks dressier."

"And that is what they did," Singer responded. "But the point is that that solution would never have occurred to anyone until the cultural root of the resistance was identified. Until then, the only response was coercion or persuasion: Wear the shoes, or else! Addressing the symptoms, not the problem. Well . . ." He shrugged. "I realized that these cultural issues are invisible to technical folks like us. We're used to dealing with systems, *but technology defines the boundaries of our systems.* All that cultural stuff is 'outside the system.' We make a proposal. It's technically sound; it's economically viable. Yet, there's resistance, and the resistance makes no sense. A mysterious roadblock here. A pointless argument there. The old run-around everwhere. Since we don't realize that the resistance is cultural—the resisters themselves may not realize it—we assume our opponents are simply being malicious and the whole thing turns into a urinary olympics."

Koyanagi frowned over the last phrase. Patel leaned over and whispered in his ear and the biophysicist made a face.

"So what are you trying to say, Charlie? Eamonn and I were resisting the nanny because it would affect our status in society? Don't be absurd."

"Hmm. The steel-reinforced work boot is on the other foot now, I guess."

"Don't make jokes! There's nothing funny about trying to avoid a nuclear war."

"No there isn't. But we were dealing with the symptoms, not the causes. *Why* should a nanomachine that enhances radiation resistance be destabilizing? Is not building the nanny really the answer? Is it a *viable* answer? Does it really address the issue? Look, do you remember the Nuclear Winter fiasco? The net result of the TTAPS report was that it made nuclear war just a bit more likely."

Koyanagi was startled. "How so?" he asked. "I supported the position."

"So did I," said Singer. "But think. Suppose their scenario had been correct. It wasn't, but let that go for now. A potential aggressor might then be tempted to launch a preemptive strike *just below* the level that would trigger a nuclear

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winter. If the victim was to retaliate, it would drive the ecosphere over the edge. An aggressor might gamble that the world would accept the *fait accompli* rather than risk total destruction. Combined with a disarmament program, this scenario becomes even more destabilizing. Yes, Jessie, what is it?"

She pursed her lips and ran a finger around the rim of her water glass. "I was going to say that that scenario isn't too likely; but that was your counterargument to me, wasn't it?"

"But the TTAPs model was not correct," said Patel. "It overstated the effects. That's why we talk about Nuclear Autumn now."

"Yes. It's still a deadly scenario, worse than anything imagined before the TTAPS report. *But not worse than anything imagined* since *the TTAPS report!* The upshot of the whole controversy was that many world leaders were left with the vague impression that a nuclear exchange was not as dangerous as some 'alarmist' scientists had thought."

"But—"

"But what, Jessie? Doesn't the same reasoning that applies to our nanny apply elsewhere? If our nanny makes nuclear war more likely, then so does the nuclear winter scenario."

"Oh!" That was Koyanagi. They all turned to look at him. "MAD is part of our pattern of culture." He looked at Singer, then at Burton-Peeler. "Don't you see? We resist anything that threatens the existence of Mutually Assured Destruction, *because it's what we're used to*. The cultural pattern provides predictability. We know what to expect from MAD: an uneasy peace. There has been no major power war since the invention of nuclear weapons; and both the United States and the Soviet Union have accepted defeat rather than use them in brushfire wars. We may not like what the pattern gives us, but at least we know what it is."

"Better the devil we know," said Murchadha, "than the devil we don't know."

"Yes, yes." Koyanagi was growing excited. "Change MAD and we don't know what to expect. It might be better; *but it might be worse*. That's what affects your status in society, Dr. Peeler. Status is not your personal prestige, but your relationships to everything else in your life."

"But that doesn't make my concerns less valid."

"No it doesn't," Singer agreed. "I've only suggested that we shouldn't use a double standard."

"Are you suggesting that TTAPS should have suppressed their original report?"

"No more so than that we should suppress the nanny. Certainly, there are risks involved in building this thing. Low level risks, but with catastrophic consequences. But there are also benefits. If we *don't* build the nanny, people will die."

"And as I said earlier," interjected Koyanagi, "nature keeps no secrets. We *cannot* suppress the nanny because others will discover it independently. Think how often such duplication has happened in the history of science."

Patel spoke up. "Doctor Singer, we have two inevitable, but mutually incompatible consequences. One is that a radiation nanny *will* be built. By our-

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selves or by someone else. The other is that, along with its great benefits, it *will* bring some undesired consequences. In particular, a greater carelessness in nuclear matters."

Murchadha nodded. "Bullet-proof vests."

"And wishful thinking," Patel continued, "will not prevent either one from occurring."

"So what do we do?" Singer asked him.

"Cultural issues are part of the system," Koyanagi recalled. He was watching Singer carefully as he spoke. "What do we do when we identify a technological problem in the system?"

"We analyze the symptoms of the problem," Burton-Peeler told him. "Diagnose the cause and effect relationships, and incorporate a preventative feature into the design. Oh, pest!" She looked at Singer. "That's what you're getting at, aren't you? How can we redesign the nanny to take the cultural effects into account?"

Singer grinned. "That's right. It's our great blind spot. Not many people in science and technology take courses in anthropology; so when we run up against a social consequence we find ourselves reduced to babbling about the symptoms. One side says risk is so small that there's no point in worrying about it. The other side says you dassn't do anything at all, because no risk is too small. Yet, when we deal with technological issues, it's a different matter."

He reached out and took the wine list from the center of the table. It was printed on a laminated plastic card. He toyed with it as he spoke. "Al Qaysar might be tempted to attack Iraq if his soldiers were radiation hardened. It's an edge, right? And he's got to do it quick, before Iraq gains the same edge. There's no point in attacking if you don't have, or think you have, some sort of edge. On the other hand, if Iraq learned that al Qaysar was secretly hardening his troops—and what nation can keep secrets for long these days?—Iraq would be tempted to attack before al Qaysar was ready. It's a dangerous time when one side has an edge over the other." He balanced the plastic card upright in front of him. He pulled his hands away and the card swayed and fell over. "Edges are always unstable."

"So what is the answer?" asked Patel.

Singer took the wine list again and folded it in half. "With two or more edges, you regain stability."

Koyanagi sucked in his breath and came out of his slump. Patel nodded slowly. "How do you plan to accomplish this?" he asked.

"You're going to market it everywhere, aren't you, Charlie? So everyone has it and no one has an edge. Will Royce let you get away with it?"

"No," said Koyanagi. "That will not work. Market forces result in diffusion patterns. Until penetration is complete, some groups will have it and some will not, resulting in the kind of instability Charles has mentioned." He looked at Singer. "It must reach everyone simultaneously; or, until it does, no one must know that it is diffusing."

Burton-Peeler laughed and clapped her hands together. "In the aerosol! Isn't that right, Charlie? You plan to put it in the Aire Fresh. My word, the way

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that is selling, the nanny will be all over the world within a year."

Singer smiled. "I thought that might work."

"No profit from it, though; unless you plan to double the price for the Aire Fresh."

Singer shook his head. "No profit," he said. "Or maybe just a little."

"What about the Lab?"

"It's like you said. We'll get by somehow. There's no such thing as defeat, you know. Not really. Except here." And he pointed to his head.

"Not everyone in the world uses Aire Fresh," Patel pointed out.

"No, but people use it everywhere in the world; and they can serve as focal points for infection."

"Infection?" Koyanagi blinked. "Then we must make it self-replicating."

"Yes. That's why I said we must redesign some of the structures."

"It will take time," cautioned Patel. "Succesful self-replication is not so easy to accomplish. The nanny will be competing with millions of other proteins and viruses. Ones that have survived eons of ruthless natural selection. That is why so many genetically engineered organisms have failed to survive when released." He looked at Koyanagi, who nodded once.

"I already have some designs prepared." Masao paused, embarrassed at having reminded them of his attempted piracy.

"Nine months," Singer told them. "No more. I can't stall Royce forever."

"That will be sufficient," Masao responded, "provided there is no more sabotage." He looked at Burton-Peeler, who flushed.

"If we brainstorm this all the way through the cultural implications," she said, "and come up with a design feature to address each pitfall, there'll be no need for sabotage. Anyway, everything will be out in the open." She turned to Singer. "That's what you meant by 'loading the dice,' isn't it?"

"But what of the possibility I spoke of?" asked Murchadha. "Not the calculated adventures of the leader with an Edge, but the *carelessness* of the leader who thinks radiation no longer matters. If everyone is hardened to radiation, so that no one has an advantage, some leaders will still become more heedless of the dangers."

Singer nodded. "Like Nuclear Winter being overstated. Or like the way Plastiphage made polluters more heedless. Yes." He looked at the wall in irritation. "We should be in the conference room with the screen so I can write all this down."

"I have been doing so," Koyanagi said holding up a napkin filled with scribbled notes. Singer laughed.

"The engineer's proposal form," he said. He turned back to Murchadha. "That's why I want the antidote. One that causes the body to reject the radiation nanny. You see, when the U.N. session opens next fall, every major world leader will be there, for the keynote addresses. And if, as I suspect, there is a major odor problem with their air conditioning system, they will naturally want large quantities of Aire Fresh to fix it. And of course, we'll have some special batches stockpiled."

By now they were all laughing.

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"Sure," said Murchadha, "Tis one thing to have one's troops immune, but another thing to have no immunity yourself."

"Don't forget the various Parliaments and Congresses and General Staffs. And not every leader will be at the U.N."

"And West Point and Sandhurst and other military academies. Can you see it? The grunts are immune, but their officers aren't!"

"What about the Kremlin? Even with this *glasnost* business, it won't be easy to give the KGB the antidote."

"We can make a start with their consulates."

Burton-Peeler leaned back in her chair and folded her hands across her middle. "You know we five aren't the only nano-geniuses around. Someone will figure out a way to counteract the antidote. And the antidote itself—"

"Right," said Murchadha. "You precede your attack with a bombardment of antidote bombs. That makes the enemy vulnerable to radiation again."

Koyanagi stabbed a finger at him. "But then you lose the element of surprise. An atomic attack can only work if it is a surprise attack."

"We can make the antidote slow-acting," said Patel. "Say it takes several weeks to establish itself and destroy the rad nannies already in the blood. No possibility of surprise then. The victims will know that they are being softened."

"But for now," added Murchadha, "we'll be keeping the antidote our little secret. No one will try to disable an antidote they don't realize exists. By then it should be well established among the target population."

"I think we should add the owners and managers of nuclear power plants to the antidote group. To discourage them from cutting corners on maintenance and such."

"Let's not be forgetting," said Murchadha, "that there are people who don't want nuclear plants or space stations to be less dangerous. Just after that fiasco at Three Mile Island, an English professor at Dartmouth, I forget his name, wrote a newspaper column. Do ye know what his reaction was to the fact that, despite a totally unanticipated failure mode and unbelievable neglect on the part of the utility management, the engineering safeguards worked and prevented a disaster? He was actually upset that no one was killed! If only hundreds had died and Harrisburg had been evacuated, he wrote, people would realize how dangerous nuclear plants were."

Burton-Peeler snorted. "And they say technocrats are ruthless? He sounds like one of those early environmentalists who preached—what did they call it? Global Triage. Ehrlich and the two Paddocks. They claimed that countries like India and Mexico were doomed anyway, so we shouldn't waste *our* food by sending it to them. They began soft-pedaling that line when they realized that even most environmentalists couldn't stomach the selfishness."

"I've got mine, buck-o" said Murchadha, "and you can't have any."

Patel only shook his head and Singer realized that Kalpit's parents were among those who would have been written off.

"And don't forget," he added, "that when Third World scientists in Mexico and the Philippines started the Green

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Revolution that eventually made those 'basket case' nations self-sufficient again, the same groups denounced it as 'elitist' because the bigger farmers got the most benefit. We can expect similar arguments against the nanny."

"It wasn't feeding the hungry that concerned them," said Kalpit with a touch of bitterness. "It was *how* they were fed. The Green Revolution was not Appropriate Technology."

"Aren't we getting off the topic?" asked Masao.

"No," said Jessica. "Because it's just this sort of thing we've got to deal with. We've identified some 'irrational' reactions, like the government's desire to stockpile the nanny as a military asset, which can destabilize the nuclear stand-off. But there are other non-technical spin-offs, like the Luddite callousness we've just been discussing. We need to consider how to deal with them, as well. Remember, in the context of their own belief system, the objectives of the Establishment and the Luddites are perfectly valid and sincerely held."

"Yes," said Singer, catching her eye. "That's what being 'realistic' is all about."

XIV

The airport was crowded and smelled of plastic and vinyl and jet fuel. People sat in hard rows of uncomfortable chairs and read books or talked or napped, waiting for their flight to be called. Singer paused on entering the gate area and looked around, searching for Jessie. Outside, through the huge, plate glass windows, a jetliner raced down the runway. Then it arched its back and bit the air with its wings and soared; as unlikely a bird as ever flew.

Singer watched its takeoff. Murchadha was already gone, on his way to Ireland; and Kalpit was hopscotching across the U.S. on a series of puddle jumpers. Masao would leave for Brazil, by way of Florida, Texas, and Mexico, later this morning.

He didn't see Jessie anywhere neaer the assigned gate and he wondered with a sudden stab of anxiety whether she had gotten the wrong gate number. He had dropped her off in front and parked the car. Now she was nowhere to be seen.

The gate area was circular, with a kiosk in the center. He began walking around the other gates. Most of them were filled as well with waiting passengers. *I hope she didn't go out the wrong concourse*. No, that was silly. Still, to check the other concourses, he would have to return to the terminal. A long walk in both directions. Why didn't airports have cross connecting tunnels between their concourses? Some did, but only when the same airline had gates on both. Was it a deliberate ploy to discourage connections to other carriers? Or were airports designed by architects who never made connections themselves?

A hand tapped him on the shoulder and he jumped.

"Looking for me, Charlie?"

He turned and gazed at her, thinking how soon now she would be gone as well. She was dressed in a comfortable, loose-fitting blouse and skirt. She wore tennis shoes, which was probably why she seemed so much shorter than normal.

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"I was looking for you in the seats," he said.

"No room. I stuck my carry-ons over there," she pointed vaguely across the gate area.

"Got your ticket?"

"Certainly, I have my ticket." Singer noticed her hand move toward her jacket pocket and he smiled to himself. *Of course, I have my ticket*, he thought. *I'm absolutely sure until someone asks me.*

"Don't worry," she told him. "We've been planning this for months, now."

Singer still felt uneasy. The Team was dispersing. Breaking up. The Lab was dark and silent once more. "I know. It's just that . . ."

Just that what? That he would miss them all terribly? That he was scared to death that they wouldn't come back?

"Just what, Charlie?"

"Nothing. I'm just skittish, is all."

"Don't worry. Everything will be fine." She lowered her voice. "Think of how many people have already been infected just by our standing here."

"I know. Eamonn left from Kennedy and Kalpit and Masao are at La-Guardia."

Burton-Peeler smiled. "I wonder what the travel agent thought of Kal's itinerary."

"I think he's making connections at every hub airport in the country. Those that Masao doesn't hit on his way to Mexico."

"The passport people didn't give him any trouble, did they?"

"Masao? No. The reports we've been feeding Royce add up to failure. Who cares about a Brass Jap on a project that didn't pan out?" That had been the tough part, he thought. Developing a plausible scenario, consistent with the experimental evidence, that "proved" that a radiation nanny for the higher phyla was impossible. He was sure that Royce would check it with other experts, probably at General Molecule, Not because he suspected deception, but to assure himself SingerLabs hadn't overlooked anything.

Masao had estimated one to two years before anyone figured it out. By then, the nanny and its anti-nanny would be endemic throughout most of the world. The people Royce would contact in the G/M hierarchy would be high enough that they would be unable to unravel the deception; while those with the competency to do so would be too far down in the trenches to be involved. He wondered if anyone had ever used the Peter Principle as a design parameter before. Unconsciously, perhaps. Every corporate worker he had ever known had taken the boss' 'stupidity' into account when laying plans.

"Worried about your part, Charlie?"

"Hmm? No. I mean, yes. Who wouldn't be? Not the cocktail circuit, but the other part. The public announcement. But I wasn't thinking about that. It's almost a year away. Just things in general," he said, scuffing the floor with his shoe.

The idea of using the world's airports to spread the nanny had been Kalpit's idea. A bit of person-to-person infection. A supply of specially doped Aire Fresh, Eamonn's "industrial strength" version, installed in the air conditioning system. Airport authorities had tripped over each other for the chance to freshen the air inside their terminals, and what

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more natural reason for Singer's crew to hop around the globe from airport to airport than to oversee sales and installation?

They had worked out the epidemiology on the computer, developing a plan to achieve maximum spread of radiation resistance within a year and a half. The anti-nanny, they had given a six month head start. It was already spreading through the upper classes.

Singer had been surprised to find that the two target populations barely overlapped. The world of private jets and exclusive resorts barely touched the world of workaday humans. So, while the nanny spread in the one group; the anti-nanny spread in the other. Each acted to immunize against the other. Inevitably, the two sets had fuzzy edges, but there was no help for that.

Spreading the anti-nanny had been Singer's task. It required going to country clubs and exclusive receptions. Meeting government leaders. Joining boards of directors. Hobnobbing with the rich. Singer's reputation and putative wealth—and his being the only Real American on the team—had given him entry.

Jessie brushed at her jacket. "You know, it's odd when you think about it. You were right. The firm needed profits. But I was right, too. And so was Masao when he said it didn't matter what we did because Mother Nature was a blabbermouth. And Eamonn was right. And so was Kalpit."

"Kal?"

"When he said that all we ever wanted to do was build better molecules."

"Oh." Oddly, he felt a tear in his eye. 'All we ever wanted to do . . .' What was so sad about that phrase? The sense of lost innocence? The memories of the time before the storm? He paused, searching for the right words. "I'm just glad we found a way out of the woods on this one," he said. Those weren't really the right words, but they were easier to say.

She looked at him. "We haven't found a way out," she told him. "We never will. We live in the woods and there's always another bear. Remember, the automobile was once hailed as the solution to the air pollution problem. Do you know how many *tons* of horse manure New York used to produce in a single day?"

"Still does," Singer responded.

She laughed softly. "You've got a comeback for everything, don't you, Charlie? But the point is that the grandparents' solutions become the grandchildren's problems. There are no permanent solutions, Charlie."

"Maybe not," he said. "But at least there are temporary ones." Maybe that was all they could ever hope for. To think things through all the way and take their best shot.

The PA system crackled something unintelligible. Singer could make out only the last part. London. Heathrow. He sighed.

"Well, Jessie. That's your flight."

"I know that."

He followed her to her carry-on bag and watched while she pulled the strap over her shoulder.

"Do you have the Aire Freshe kits?"

"Yes, Charlie. I have the Aire Freshe kits. They're going air freight. Half the airports in Europe want one, and the other half will, once the word gets around." She fiddled a little with her

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strap. The steward by the gate said something into the microphone and half the people in the waiting area stood. They shuffled into line, using their luggage the way a running back used an offensive tackle. Singer couldn't see what point there was in getting a few slots ahead in the line. They wouldn't slam the door shut in someone's face. "They're calling my row number," Jessie said.

"Yeah," he said. "Well. Good luck." He wanted to ask again if she had her ticket with her. They embraced briefly and she turned to walk on the plane.

Then he did find the right words. "Are you coming back?" he asked, just loud enough for her to hear.

Jessie paused and looked over her shoulder. His pulse throbbed and his breathing was shallow and quick. He was afraid of her answer. Deep rifts had opened up between them; rifts that had been patched over by the work on the anti-nanny, but which remained just below the surface. They had done things to each other that neither could forget.

"I'm not sure," she said at last. "A lot has happened. I'm not sure anymore who you are. I'm not even sure who I am."

"Come back then, and I'll introduce us."

They stared at each other for a long, awkward moment. Then Jessie sighed. "Oh, what the hell. I'm an old lady, too old to change my ways; and I'm used to having you around." She hefted the shoulder bag again and turned and walked down the jetway.

He watched her until she turned the corner and was out of sight. Used to having him around. Singer decided that that was the most tepid declaration of love he had ever heard. Maybe it wasn't much, but it was something. How did the old saying have it? You like "because;" you love "despite." With all his faults, with all her faults, neither of them were willing to give up on the other. Maybe it was pride, not love. Maybe neither of them liked to admit defeat. And maybe, he thought, not giving up was what love was all about.

"Please, Dr. Singer. You must come out. It's deadly in there."

Singer did not look up from his book. Slowly his mind returned to the present. The plant manager was a fool. Didn't he realize that Singer knew quite well how deadly it was? More to the point, didn't he realize how many rads Singer had already absorbed?

Probably not, he decided. The plant manager was probably financially trained, neither a biophysicist nor nuclear engineer. He no doubt knew everything there was to know about nuclear power plants except what was important.

"Entry to the containment building is for authorized personnel only!"

Singer didn't bother to answer that one either. If the lack of proper authorization had not stopped Singer from entering the containment, why on earth should the man think it would persuade him to leave?

"You are trespassing! I'll have you in court, celebrity or no celebrity!"

That meant nothing either. Before this was over, he'd have a lot more than trespassing to answer for. *We must have violated every regulation in the books.* Sweat rolled down his brow and he mopped it with his handkerchief. Waste heat from the nanomachines in his

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blood. Either that or he was nervous as hell.

Probably both, he decided.

"Mr. Davis," he said, addressing the plant manager. "Have the media arrived yet?"

"They have. Someone tipped them off." Davis peered suspiciously, at Singer, at the engineer, at the tour group.

"Invite them in, then, if you please. I have an announcement to make." He saw two of the biologists in the tour group look at each other. One of them was making notations in a pocket notebook. The engineer was watching him with hard, appraising eyes. Estimating rads, thought Singer. He knows.

"I will not invite them in. This is a power plant, not a circus for ghouls. I will not have my operations disrupted."

"Mr. Davis, you are shut down for a P.M. There are no operations to disrupt."

Singer gave him his best stubborn look and, after a few moments, Davis wilted. "Very well." He strode to the red wall phone and spoke into it.

Singer grinned at the two biologists and pulled a pair of sunglasses from his pocket and put them on. The biologists grinned back. The engineer shook his head, whether from pity or admiration Singer did not know.

All the while a little voice in the back of his head kept up a running commentary. There were limits to the nanny. Limits to the radiation level and exposure time. Kalpit and Masao had calculated how long he could stay in here. But what if they had made an error? Everyone had checked the calculations several times. He had checked them himself. Still, what if there had been an error?

Why then I'm already dead, he told the little voice, and it doesn't matter at all.

And that shut the voice up very nicely.

The news people spent a considerable amount of time setting up and jockeying for position. Singer watched them, wondering what customs they used to settle issues of status.

I've got to explain everything to them. The benefits. The limitations. The dangers. Especially that of increased carelessness. Everything but the antidote. Let them think that some people are immune to the nanny. Someone will figure it out sooner or later; but by then everyone should be used to the nanny. *It will be part of the cultural pattern and we'll have learned how to live with it.*

He was surprised to see John Royce file in with the reporters. Royce stood toward the back of the crowd, with his arms folded across his chest. His face gave no hint as to what he was thinking. He could be waiting to arrest Singer when he finally came out. Or he could have realized himself that this was the best way. Best for the country.

Finally, the reporters sorted themselves out. They stood with their tape decks and microcams aimed at him. One or two glanced nervously at their dosimeters.

Singer stood and put his Heinlein back in his jacket pocket. He brushed himself off and stood in front of the viewing window. He smiled at them.

"I've got some good news and some bad news." ■

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Jay Kay Klein's biolog

Born in England just in time to be a teenager during the exciting years of WWII, Pauline Whitby Ashwell has managed to combine what often seems an English predilection for sandwiching periods of sleepy village tranquility with high adventure in the furthest outreaches of the empire. With a father as headmaster of a small local school, Pauline's academic bent got her an early wartime admission to Oxford, in St. Hilda's College, to study zoology.

Jobs followed as a junior lecturer at University College, London, and in applied nutrition at the London School of Hygiene and Tropical Medicine. Then on to Ghana and Sierra Leone as a nutrition officer in the Ministry of Health, with a stay of some years in Zambia trying to puzzle out just how the country could best feed its population.

At University College she had a chance to meet some of the great scientists of our time, such as J.B.S. Haldane, Peter Medawar, and D.M.S. Watson. She saw the early stages of the development of biochemical genetics and other exciting areas which are now bringing astonishing results. Overseas she saw willful, ignorant rulers who secured power and wound up impoverishing their countries.

She is now a dedicated part-time writer with a word processor in the peaceful village of Ashwell, which is just starting to be overrun with commuters from a once distant London. At the age of twelve, Pauline received sixpence short of a pound for a 950-word story. When she was fourteen, having read all the science fiction she could get her hands on since age nine, she had "Invasion of Venus" accepted for publication in England. After some desultory efforts, she hit the big time with this magazine, publishing a short novel, *Unwillingly to School*, in the January, 1958 issue—marking her as a discovery of John Campbell, the long-time editor credited with forming modern science fiction.

This writer likes to mull stories over for twenty or thirty years before getting them just right. The novelette "Rats in the Moon" appeared here in November, 1982, though it was started 35 years earlier. Some plot details needed working out, you see. Many stories are prompted by a take-off on an interesting title, or elements catching her fancy. On the other hand, that new computer is speeding things up so that "Thingummy Hall" took only four days to write after it was conceived at last year's world science fiction convention in Brighton.

She likes stories that can only arise from the scientific elements of their setting. She deplores the type of writing that searches for a fancied literary respectability by mining plots from outside science fiction, and dressing them up with scientific trappings not essential to the stories along with human conflicts that are on some current "approved" list. Pauline will continue to think furiously about the interesting things that can happen in our far-flung galaxy while living a quiet day-to-day life in an English village. ■

Pauline Whitby Ashwell

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the reference library

By Tom Easton

My Father Immortal, Michael D. Weaver, St. Martin's, $16.95, 240 pp.
A Talent for War, Jack McDevitt, Ace, $3.95, 320 pp.
Crystal Witness, Kathy Tyers, Bantam, $?, ? pp.
The Dark Door, Kate Wilhelm, St. Martin's, $16.95, 248 pp.
Alternities, Michael P. Kube-McDowell, Ace, $3.95, 397 pp.
The Tides of God, Ted Reynolds, Ace, $3.50, 256 pp.
The Player of Games, Iain M. Banks, St. Martin's, $16.95, 288 pp.
Women of Vision, Denise Du Pont, ed., St. Martin's, $14.95, xii + 163 pp.
The Dragonhiker's Guide to Battlefield Covenant at Dune's Edge: Odyssey Two, David Langford, Drunken Dragon Press (84 Suffolk Street, Birmingham, B1 1TA, England), £9.95, 142 pp. Available in the U.S. from: Dreamhaven Books and Art, 1300 4th Street SE, Minneapolis, MN 55414.

When Michael D. Weaver's *Mercedes Nights* came along, I blew the trumpet and said I would be looking for his next: It's **My Father Immortal**, and in some ways it's just as satisfying as its predecessor. It's a simpler tale, less pyrotechnical, less convoluted. Yet it impresses.

The novel begins as Tiffany Tyler-Grant puts her two tots, plus those of her sisters, aboard individual survival pods. She is, you see, aboard a starship leaving the Solar System, and the children are so unwanted by the rest of the crew that they will be put to death. She wants the kids to return to Earth, though the journey will last them from age two to adolescence. With them, she sends programming for the pods' computers to educate and entertain. Her son, Daniel, gets her personal memoir.

The kids grow and learn. In due time, they learn how to communicate, in writing only, from pod to pod, and then Daniel undertakes to write his mother's tale. And we learn of an Earth devastated millennia before by nuclear war. In one place survive mutants of apparently supernatural indestructibility. To them, weaponry is mere toys, and their dog plays fetch with live grenades. The focus of their lives is music, though one is at least as fond of reassembling devices from the past and distilling booze.

To this outre settlement comes a confused and naked girl, Tiffany herself, released by fate from a suspended animation facility buried nearby. Tiffany's brother Philip is awakened by the computer that runs the facility and told to retrieve his sister. He kills a mutant, and war is joined.

Philip and Tiffany, Weaver soon reveals, are two spoiled rotten members of a ruthless, wealthy family that decided to put itself away when Armageddon seemed too likely. They would awaken, they thought, when the Earth had recovered, and it would all be theirs. They are therefore dismayed to learn of the mutants, and worse dismayed to be defeated and imprisoned. Still, Tiffany and her sisters find in the new situation a sense of escape from family tyranny. They take lovers among the mutants. They are content.

But there is another suspended animation facility, with more, and nastier,

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members of the family. They awaken, attack, nuke the mutants, rescue the captives, including those who have no wish to be rescued, and load everyone into the reserve escape hatch, the starship. (I presume they didn't use it in the first place because they had their greedy eyes on Earth.)

As Daniel reaches this point in the narrative, the kids realize that their skin does not scratch or bruise. They share some features of the mutants, which in turn owe something to the Tyler-Grant family. And the pods reach Earth. What will the kids find? Could their indestructible fathers possibly have survived nuking? Could there be a future on Earth for a kinder, gentler, tougher humanity?

For the answers, read the book. You'll enjoy it.

The beginning of Jack McDevitt's second novel, **A Talent for War**, did not impress me. It was perfectly competent, but it was also perfectly familiar: Alex Benedict learns that his uncle Gabe was on a starship that disappeared. Uncle Gabe is presumed dead, and Alex is the heir. Now he must come to Gabe's home world to receive the password that will open up a secret computer file and reveal the treasure Gabe, an amateur historian, has located. Then Alex can retrieve the treasure, fulfill his uncle's dreams, and retire to a life of ease. But before he can check out that computer file, it is stolen. Now Alex must play detective, and I must wonder how many times I have seen this plot before.

Happily, McDevitt does rise above his initial plot cliché. The technology helps: People communicate via "sponders," software personality simulations with which one can hold limited conversations; household computers have a good deal in common with classic butlers; and people visit libraries and go shopping (and play detective) by donning a headband that allows them to roam as, in effect, disembodied viewpoints. And then the story behind Gabe's death and the burglary begins to come clear: Two centuries before, Christopher Sim was the grand hero of a war against the alien Ashiyyur. Sim fought desperately while his brother rallied the human worlds. He died at Rigel, however, just as humanity's major worlds joined the fight. Or did he die? Alex pokes and pries, visits historical sites, ruminates, and reveals history for the reader as he reexamines it for answers to crucial questions. There are hints that Sim and his ship were seen later, and the records suggest the impossible, that Sim's ship could be in different solar systems on the same day, despite the obvious fact that travel took weeks. Did he have two or more identical ships to confuse the enemy and Alex? But Alex learns that a modern exploration ship has found a mystery in the Veiled Lady and declared total secrecy; there are signs of other searches, both contemporary and past, post-war; there are . . .

Alex struggles on, uncovering signs that the historical record is seriously flawed, learning where to go for the truth, and finally going there, to discover and learn. . . . What? I will say only that McDevitt justifies all the mystery, answers all the questions, unifies civilization, wards off war with the aliens for the foreseeable future, and surely satisfies every reader. *A Talent for War* may not be perfect, but it confirms a prodigious talent for SF. Don't miss.

Kathy Tyers recently sent me a thick wad of manuscript, saying, "This time, I'm determined to beat Bantam Spectra at getting a review copy to you. I enclose my third novel, **Crystal Wit-**

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ness . . .''

She did indeed beat the official galleys, and I'm glad she did. I enjoyed the book, and so will you. It is set in a distant future, after humanity has spread among the stars, and after an interstellar radiation storm has contaminated space and isolated the various worlds. An answer comes when the Renascence Shielding Corporation, known as Renasco, finds a way to shield against the radiation, contacts the worlds, and offers its services. The price? Simply a monopoly on transport and all the associated technologies. Space is ruled by company cops, and if you run afoul of them, your brain gets scrubbed clean of memories and your body becomes a slave.

The tale begins with a crew from the desert world of Cabra Minor. They have pirated the shielding technology, and they are smuggling Cabra Minor's rare and costly sunstones. But they are caught; one of that crew, Ming Dalamani, is mind-wiped, her spine is fitted with a device that can, on remote activation, paralyze her, and she is told that to earn her freedom she must spy on Holjpip Langelleik, chief of the Renasco world of Mannheim. But she will ostensibly be a mere 3D calligrapher.

Guess where Ming's loyalties lie. She hates Renasco, but she craves freedom. And then she finds friendship and love on Mannheim, memories slowly return, and she learns that Holjpip is not the typical Renascan. She is recruiting a corps of creative, artistic people, and she is herself deserving of all the loyalty Ming once gave her clan. And then Ming, snooping in the computer files with a password that sprang to mind—a memory of the old days of technological piracy—learns that Holjpip has plans.

I felt that Tyers overdid Renascan villainy more than once. For instance, why in the world does the company find it necessary to terrorize its own employees? To remind them who is boss? But they need no reminders, for all too often their brainscrubbed servants were once their superiors.

Yet she does not make the mistake of letting ''Renascan'' become a synonym for ''villain.'' Yes, the corporation has villains aplenty. But it also harbors victims, and resisters, and outright rebels. *Crystal Witness* is the tale of those non-villains and their victory.

Kate Wilhelm's **The Dark Door** is a strange and unsatisfying hybrid. The first element of the hybrid is old, abandoned hotels (remember King's *The Shining*?) in which something horrible seems to dwell. It occupies some high, antique doorway with a sheet of unreflecting blackness, a gateway to its devouring self hidden in some other dimension. It emanates a psychic field that drives people in the vicinity to madness and murder and then draws both the quick and the dead through the gateway; it hates anything electrical; and, when it is driven out by fire, it soon locates another inn with high doorways and takes root again.

Yet Wilhelm's *something* is neither supernatural nor an actual embodiment of evil. She tells us first off, even before she introduces us to the first of the inns, that the something is a spaceprobe from some distant world whose people think and build and manipulate in patterns of colored lights; launched long ago, the probe immediately went awry, with a dark shadow—another dark door to match Wilhelm's title—cast across its lights. The story then begins as a couple, their son, and an insurance man enter an inn, the atmosphere turns dark, the son slaughters, and Papa, immune to the monster (though it gives him

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headaches) survives. Papa then burns the inn and, when he notices a similar pattern of madness elsewhere, assumes the mission of tracking the monster to each successive lair and burning it out.

Not surprisingly, the string of fires alarms the insurance companies, who then call upon detectives and arson experts Charlie Meiklejohn and Constance Leidl. Charlie and his wife quickly spot the pattern, hie themselves to the next inn, and collar Papa before he can set another fire. But now they must try to convince the authorities of what the monster really is. And then they must fight those same authorities in order to destroy the monster.

Wilhelm's characterization is lovely, while the plot moves very briskly. So why do I call *Dark Door* unsatisfying? It has everything, hasn't it? Sneaky, gothic, scream-in-the-dark horror. First contact with strange and deadly aliens. Clever, insightful detectives, one of them a woman who thinks nothing of heaving FBI agents into the trunk of her car so she can flee across the snow to a rendezvous with destiny.

Perhaps that's the problem. *Dark Door* has everything, yes, but that everything sounds a lot like the clichés of three genres. What's worse, the mixture of genres, clichés and all, fails to jell. Detectives and horror go together just fine. But the SF component, though it attempts to rationalize the horror, does not fit. It seems entirely unnecessary. Furthermore, it seems unlikely that a psychic field can have so much in common with electrical fields that it cannot function in their presence yet remains undetectable to electronic apparatus.

I also object to the speed with which Wilhelm's detectives leap to the conclusion that, "Aha! It can't be spooks! It has to be an alien space probe!" when all the evidence, such as it is, points to spooks. You say that Charlie is an arson investigator, an eminently rational occupation, and that he isn't about to reach for spooks as long as there remains a single rational, objective answer, however far out it may be? He still comes up with the space probe truth far too easily. Wilhelm enlists his rationality to defeat the clichés she offers us, but she makes his rationality so facile that it becomes just one more cliché.

I enjoyed Michael P. Kube-McDowell's **Alternities** rather more, at least once I got past the halfway point. The setting is an Earth that differs greatly from our own, in recent history, popular culture, politics, and economics, yet is much the same in human wickedness and ambition and fear. The U.S.'s President Robinson is a megalomaniac who wishes to destroy the Russians even if that means destroying his own nation, perhaps because in this Earth the Soviets enjoy greater prosperity and freedom of speech and thought than those who live in isolationist Fortress America. Sadly, Robinson has the means to escape the consequences of his madness, for some years before, in 1966, Walter Endicott stumbled into a gateway from his Earth to this one. He found his counterpart, murdered him, took over his life, and became a senator who keeps anonymous women locked in a suburban dungeon, where he does nasty, nasty things. And one day, he tips Robinson to the existence of the gateway to other Earths, the alternities. The president quickly moves to exploit—in secret, of course—the alternities, first as a source of inventions, of wealth, and then of potential safety.

But here is Rayne Wallace, a "runner" who traverses the gateway with messages, medicines, and counterfeit money. His job demands that he neglect

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his wife, and he cannot tell her why. Their marriage is falling apart. And then Robinson's schemes propel him into Alternity Blue, where the U.S. population is organized into a nationwide "neighborhood crime watch." He finds there a truer love than he has ever known, she notices the incongruities of his existence, and he becomes a captive fount of information. The Blue authorities soon realize that the gateway is an artifact and that Earth has been multiplied in order to . . .

No. I won't say. Kube-McDowell's tale develops slowly and methodically but with inexorable logic toward a probing consideration of the extent to which others are as real as oneself. This question has its roots in solipsism. Here, the solipsist can be an entire world, and the question becomes, "*I* am real. Given that, what are all those duplicates of me among the alternities? Imitations? Automatons? Dolls?" Yes, says the author, it can be difficult to admit that other people are as real as we are. It is even more difficult to admit that truth when those others seem identical to us. But we *must* admit it, for only then can we grow up.

The main problem with the story is its slow development. Only once we can glimpse where Kube-McDowell is going does the tale become really interesting. The problem is aggravated by the fact that many of the villains are drawn from stock; they are cardboard. Only when we begin to glimpse their uses—in the spirit of editorial cartoons, perhaps—do we forgive their thinness. And once we are past those two obstacles, the tale becomes interesting indeed.

Alas, I suspect that too few people will stay with the tale long enough to get interested.

The Tides of God is an interesting, absorbing, action-filled tale which, surely much to the delight of the religious among us, just may lack the integrity of its convictions. The problem only begins with the silliness of reducing all human relationships to matters of contract, simply to demonstrate what a truly rational lifeway, uninfluenced by mystical bullshit, must be like.

Author Ted Reynolds gives us a new twist on the Nemesis hypothesis. Where others say that a dark star periodically triggers cometary showers that extinguish dinosaurs, and may someday wipe us out, he tells us that another cycle matters more to humans, that of dark ages, enlightenments, and civilizations, with our own civilization due soon to collapse into religious barbarism. The reason is simple: God is an alien, or an alien artifact, that follows an orbit among the stars that every thousand years or so brings it close enough to Earth to affect humans with its psychic field. Sadly, humans respond to the field in different ways. All go irrational, mystic, superstitious, and absolutist to boot. Since few agree on how to interpret "God," there is war, persecution, intolerance, and the collapse of civilization.

Now humanity has been contacted by an alien species which has also suffered its brushes with "God." Like humans, this species is contract-minded to a fault. It offers humans a humongous starship, if only they will use it to go forth and kill "God" before it comes within range of the alien and human worlds again.

Unfortunately, before one can shoot at "God," one must get within range. When one does so, "God" warps one's mind, and those of one's fellows, so that society aboard ship becomes rather chaotic. It's a wonder anyone ever gets a shot off, and even more of a wonder

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that Reynolds's supremely rational humans and aliens were incapable of predicting the difficulties and of trying a few automated missile-launchers first.

Where is the failure of integrity, the cop-out? It comes in at the end, with a clear denial that "God" was, after all, alien, material, artifactual, finite, and destructible, and with a very strong suggestion that the Second Coming could be a matter of possession.

What's wrong with that? Might Reynolds not be lecturing the atheists among us on their delusions? Maybe so, but he is extraordinarily convincing in his portrayals of the evils of belief and, despite the Gulliverian exaggeration, in his faith in rationality. The reader *believes* in this God-shoot. Or might Reynolds be a fatalist who thinks that rationality fights a losing battle, that the attractions of superstition are so strong that the dark ages must ever return? Maybe so, and I am almost convinced. But his ending did make me say, "Bah! Cop-out! No follow-through!"

Perhaps you'll disagree.

Some centuries after the time of his *Consider Phlebas*, Iain M. Banks returns to his vast galactic Culture, in which human and artificial intelligences coexist on equal footing (although some artificial intelligences, the Minds, are equal only by courtesy to mere humans), without money or war (except when some outsider wants to stir up trouble). The story is that of **The Player of Games**, one Gurgeh, a multi-game equivalent of our chess grandmasters. With centuries of experience behind him, he knows every game there is to know, and let's note that he has only sneers for such simple-minded, linear, deterministically computable games as chess.

But, Gurgeh is bored. He craves something new, and he puts the word out, through friends, to the Culture's Contact section. Contact soon contacts him with a proposition: There is, in the Lesser Magellanic Cloud, a civilization, an Empire of a thousand worlds, that bases itself on a complex game, Azad. The Empire of Azad is also a fairly nasty outfit, but that's beside the point, right? The game's the thing, Gurgeh, and we'd just love to have you trek out yonder and show the yokels how the Culture does its stuff.

He agrees. In due time, then, he is made as welcome as a xenophobic culture can make an alien and allowed to enter the tournament whose ultimate winner will become Emperor. And, against everyone's expectations, including his own, he starts winning games.

I won't tell you how it turns out. It is enough to say that Banks is playing with an extension of the Whorfian Hypothesis (that language shapes thought), saying that a culture's games both reflect and shape its thought patterns. Gurgeh becomes so deeply absorbed in the game of Azad that he almost becomes an Azadian. He forgets for a bit that reality itself is a game, and he must reject the Azadian reality in favor of his own. That is, to save his soul and his Culture, he must somehow play the game as a representative of that Culture and show the Azadians just how ruthless a bunch of sybaritic, decadent individualists can be, once they get their dander up.

It's worth the price, folks. Don't be put off by the tone of involuted preciosity that pervades the tale's beginning. That's an important part of the point: Life's a game, and the winners, in anyone's reality, are those who play the game best.

Women of Vision, edited by Denise

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Du Pont, is a collection of essays by a dozen women science fiction writers: Ursula K. Le Guin, Virginia Kidd, Anne McCaffrey, Patricia C. Hodgell, the late Alice Sheldon, Suzette Haden Elgin, Lee Killough, Marion Zimmer Bradley, Eleanor Arnason, Joan D. Vinge, Pamela Sargent, and Suzy McKee Charnas. Du Pont apparently obtained the essays by sending out a list of questions; Elgin's essay answers those questions quite explicitly, one by one, and others allude to them. The questions probed most interestingly at the roles of feminism and femaleness in the writing, and the results reveal the essential humanity that -isms of all kinds obscure. The results also furnish several metaphors—carrier-bag, nomad, no-road — that, quite independently of gender, might prove useful to young people seeking a grasp on the writing life, or to older hands who feel their grasp slipping.

It's thought-provoking, illuminating, and worthy of your attention. Enough said.

The Dragonhiker's Guide to Battlefield Covenant at Dune's Edge: Odyssey Two is precisely what you might gather from the title for laughs. More precisely, it is a collection of David Langford's parodies, many of which have been published in the fan press, a couple of which have appeared in one of the smaller prozines, and a few of which have until now been mercifully withheld from public view.

Actually, one or two aren't half bad. I have in mind the Grimm parody in which the frog gets the princess and the Hodgson/Dunsany jape whose ghost is a man of, um, *parts*, don't y'know. As for the rest . . . let us say simply that they are strained, and then add that "Drunken Dragon Press Limited is a new company set up by Rog Peyton and Rod Milner to publish works of science fiction and fantasy in both standard hardcover format as well as in a small limited run with de-luxe (sic) binding and finishings." In this case, "de-luxe" means 100 leather-bound, numbered, and signed copies with marbled endpapers, @ £24.95.

ANADEMS

Thanks to a poem, I've just received copies of issue #17 of *The Leading Edge*. It's a small (92 pages), small-circulation, thrice-yearly, "semi-professional" SF magazine put out at Brigham Young University in Provo, Utah, and it's better than many of its kindred. In two articles, both based on master's theses, Bruce N. Westergren discusses the history of society's view of robots, in and out of SF, and Jay Don Coppersmith tries to acquaint more people with the world of Peake's Gormenghast trilogy. There are also an interview with Ray Bradbury, a small book review section, and four poems, three of them among the high placers in BYU's 1988 Odyssey Poetry Awards contest. Of the five short stories, the freshest may be Norman L. Quincy's "That's Not Kosher," in which non-kosher deli food contaminates an orthodox wizard's wand, or perhaps Carolyn Nicita's "Siege," a piece of opaquely bizarre surrealism. The other three are distinctly derivative, and all five show their authors' lack of experience. Yet all five are also worthy efforts that hold some promise for the future.

The Leading Edge specializes in the presentation of new and upcoming authors, artists, and poets, and it has ambitions "to serve the entire SF&F community, not just the local one." It therefore deserves encouragement and support. You can join its cheering sec-

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tion by subscribing ($7.50 for one year, $14 for two, $20 for three) or by submitting your work. You won't get rich if they take your story—payment is just a quarter cent per word—but there is a yearly fiction contest as well, with somewhat more tangible cash prizes. The address is *The Leading Edge*, 3163 JKHB, Brigham Young University, Provo, UT 84602.■

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brass tacks

Dear Mr. Schmidt:

I've just read your July editorial (A Requiem for Summer?) about the prop sed twelve month school year. Here in Canada the debate has also begun, so it was with some dismay that I learned that the process seems to be farther advanced in the United States.

Like you, I spent the summers of my youth roaming through the forests and fields near my home, and through the world of books, which I had more access to in the summer, since I simply had more time then for reading. It was during one of those summers that I discovered science fiction. The stories of Chad Oliver, C.M. Kornbluth, Arthur Clarke, Philip K. Dick, Theodore Sturgeon, and others are for me forever linked to those solitary afternoons in the dappled shade of the maple tree behind my home.

We twentieth century men and women, at least here in the West, take it for granted that we live free lives, but I have always believed that you had to have experienced freedom to know when you've got it and when you don't. There is no doubt in my mind that it was during those wonderful summers away from school that I first came to know what it feels like to be truly free.

It's hard to believe that anyone would want to do away with that.

KEN ENSTON

Toronto, Ontario

Dear Mr. Schmidt,

I am writing to you personally to inform you that I am not renewing my subscription to *Analog*. I have been a subscriber for the past 10 years, and I have looked forward to receiving each issue, at least I did, until I read a letter in Brass Tacks and your response to it.

The letter to which I am referring was from Jackie and Craig Lane from Tor-

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rance, CA. They were disturbed by a mailing they had received from the Planetary Society, soliciting membership, by means of a "survey/questionnaire". It was difficult to tell from the Lanes's letter whether they were more upset by the mailing, or by the fact that the Planetary Society, NASA and the United States all seem to be focusing on Mars as the next Space project. Your response commented only on the style of mailing being used, and for that I commend you.

My husband and I are charter members of the Planetary Society. We have attended numerous events sponsored by the society including the *Voyager II* encounter with Saturn in 1981, the Comet Halley symposium in Washington D.C. and the *Voyager II* encounter with Uranus. All events were well attended, most to standing room only, due in large part to the popularity of Carl Sagan, the Society's president. We will honestly admit that if Carl Sagan's name had *not* been associated with the Society we probably would not have joined all those years ago. But we did! And we now contribute generously every year to this organization which has proven to make a difference in U.S. space policy.

The events we have attended are superbly run, fascinating and extremely informative. The publication put out by the Society, *The Planetary Report*, is a beautiful, high quality product with wonderful articles, reviews, photos and paintings which only serve to heighten our enthusiasm for space!

I may be terribly naive, but if the Lanes felt so strongly about the policy being discussed in the "survey" (I have a copy of it), why didn't they answer all the questions and then voice their beliefs in writing and send it back? Maybe it wouldn't have been read, but maybe it would!

The Planetary Society is composed of people of various beliefs regarding the future of space exploration. By not responding, except of course to your magazine, the Lanes have discouraged many people from taking the time to even *read* the Society survey, let alone join the organization! And I also am blaming you, Mr. Schmidt, for criticizing the "survey." If you wanted to criticize it, at least you could have credited the Planetary Society for their successes and the quality organization they are. Of course this is all just my opinion, but if Mr. and Mrs. Lane are entitled to an opinion, then I am too.

AMARYLLIS

Pasadena, CA

I'm on your *side! It's precisely because I* do *believe that the Planetary Society does important and valuable work, and because many people will react as the Lanes did to that kind of solicitation, that it bothers me to see the Society using it. Their work, and that of several other groups using it,* needs *the support of people like the Lanes. They cannot afford to use a recruitment approach which will alienate precisely the people whose help they need.*

I do not believe that the Lanes's failure to respond to the "survey," or my reply to the letter they sent me, will discourage anybody from reading the survey or joining the organization. The survey itself does that—which is why the society should quit using it. Research is the lifeblood of an organization like the Planetary Society; when they send somebody not familiar with their work a sales pitch that inaccurately calls itself "an important research survey" or something equivalent, the recipient is likely to consider that misuse of an important word a strike against the society's credibility. He or she is likely to bother responding as you suggest only if he or she is already quite interested

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in what the society is doing—especially since most people get a veritable deluge of similar mailings.

So I repeat: the Planetary Society's work (like that of several other groups) is important, valuable, and needs support. I'm sorry that point did not come across in my reply, but that would have been a digression from the real subject at hand—which applies to other groups as well. But the Society—and any research-related society which uses this kind of mailing—is shooting itself in the foot (or letting its PR department do it for them). The point of my reply to the Lanes was that people like you and your husband—members of the Society who care about its work—should be trying to see that that is stopped.

For the Society's own good.

Dear Dr. Schmidt,

I enjoyed reading Mr. Stine's article on computer illiteracy (December, 1988). I agree with his contention that we as a society are "faced with an enormous problem at the human/machine interface." However, there is no need "to transfer some of the creative energy of the hardware/software designers . . . into the area of making the interface easier for people" as there already exists a field of study that specializes in these issues. Though not well known, this field has been around since WWII.

The field of study that specializes in studying the human/machine interface includes psychologists, industrial engineers, computer scientists, and various other professionals. The practitioners in the field are known by several titles; in the U.S. the terms human factors engineer and engineering psychologist are most common (the U.S. has a few Engineering Psychology graduate programs). In Europe the term ergonomic engineer is commonly used. The roots of human factors originated during WWII. During the war it became apparent that humans were committing serious errors with the new, complex machinery used in the war. Research first focused on selection and training issues so that humans could be fitted to the machines. It became apparent, however, that even well-trained personnel, such as pilots, were committing serious errors (e.g., retracting landing gear during approach). In this instance, an investigation of the accidents found that the knobs on the throttle and the landing gear controls were identical. This led to research on knob shapes which could be quickly distinguished by touch. Research began to focus on designing the machine to fit the human.

The Human Factors Society has a large membership with many interest groups, including a computer systems group. This group investigates a wide range of research and design issues concerning the human/computer interface, or in other words, fitting the software to the "jellyware." Human factors specialists in this area often develop software prototypes that look and feel like the application without being hard-coded. Findings from basic research on human capabilities are incorporated into the prototypes, called "vaporware," and tested for its ease of use with jellyware. After several iterations of test and design the vaporware is converted into software.

While I do agree with Mr. Stine that voice activation may make some systems easier to use in some cases, I can think of numerous applications where such an input technology would be a nightmare (think of using a voice-activated directory in a busy and NOISY airport). Furthermore, there are numerous technological hurdles which must be met before such systems are com-

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mercially feasible, though they already exist in some specialized applications (e.g., to assist paraplegics). Before voice-activated systems can become widely available, the system must be able to recognize voice variations. Unfortunately spoken language varies dramatically for each individual at different times (as when suffering from a head cold), from person to person, and from region to region (as a Bostonian who worked in Texas, I am especially attuned to this difference).

Also, simply applying voice input does not make the computer dramatically easier to use. Think about taking away the keyboard from your computer that runs DOS and putting in a perfect voice input system—you still have to remember all the commands! (Yes, such systems do exist). There are other new input technologies besides voice input that promises to revolutionize how we interact with computers. One such example is the "data glove" which allows the user to "grab" objects on the screen (with tactile feedback!) and move them directly. You can also press buttons and use gestures such as an "OK" hand configuration to confirm an action. Work is also being done on making a "data suit," see *Omni* magazine (September, 1988, p. 22).

I also take issue with Mr. Stine's statement that "hardware & jellyware differ only in structure"—this is just not true. When was the last time you could remember the number pi to 18,000 digits? A computer remembers everything verbatim. Humans don't. They actively processes events, names, places, and things into and store them as abstractions—only a few individuals have "exact" or photographic memories.

A view that hardware and jellyware is very similar often leads to very poor human/computer interfaces. For instance, the interface at my college's computerized library catalog forces me to "think" the way a computer thinks—literally. When requesting a book I have to remember each word of the book title in its exact order (Yes, I can use abbreviations, but it doesn't help if I can't remember word order). The other day I was looking for a book entitled "Taxonomies of Human Performance," but I remembered and entered the title as "Human Performance Taxonomies"—no dice, that book doesn't exist!

I agree with Mr. Stine that more effective human/computer interfaces are needed (and hopefully will be designed in the future with the assistance of human factors engineers), but I also believe that we need to increase the number of computer literates in our nation through education. Even a well designed human/computer interface cannot cure ignorance.

MARK SHURTLEFF
Engineering Psychology
Graduate Student
Las Cruces, NM

Dear Dr. Schmidt:

"Remembered Kisses," by Michael F. Flynn, was the finest short story I remember reading in *Analog*. It was as emotionally affecting as "Enemy Mine." (Did I first read that one in *Analog* as well?)

Part of me opts for so-called "hard" science fiction to play with impersonal puzzles and avoid the intimate turmoil of people. This story, however, hooked me on Henry's pain before the rather obvious, morally reprehensible, but human resolution was presented.

MARVELOUS!!!

C. R. (RALEIGH) REDUS
Oakland CA

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Dear Dr. Schmidt,

In the Brass Tacks column for March 1989 there was a letter announcing the formation of a "Spacepac" organization that would promote the election of pro-space politicians. The author was asking for $40 in membership dues per year as well.

I applaud the author's initiative and recognition that direct participation in the political process is crucial to space development, but I take great exception to his use of the name "Spacepac." I hope you will let your readers know that a Spacepac already exists and it has been quite active this year!

Spacepac was registered with the Federal Elections Commission as a political action committee (or PAC) in 1982, and has contributed funds in every congressional election cycle in that year and since. When the L-5 Society and the National Space Institute merged to become the National Space Society (NSS) in 1987, Spacepac became affiliated as part of the NSS's family of organizations. Spacepac is the political action arm, raising thousands of dollars for pro-space candidates nationwide. Spacecause is the other family member, a lobbying organization that has pushed for Space Station funding, legislation promoting a strong U.S. launch vehicle industry, and endorsements of space settlements as a goal of U.S. space policy.

If the author attempts to register with the Federal Elections Commission, he will find the name "Spacepac" already in use. We would welcome him to participate with us, however, in raising campaign funds in his home state as we have chapters nationwide. (Contact: Dale Skran, Spacepac Chapters Coordinator, 23 Main Sail Square, Freehold, New Jersey 07728) I would also urge him to become an active member in the National Space Society. He has only to contact NSS Headquarters in Washington, D.C. at (202) 543-1900.

Thanks for your help in clearing up this name confusion and I only wish more space enthusiasts felt as he did about the importance of political participation!

SCOTT PACE
Director Public Affairs
Santa Monica, CA

Dear Dr. Schmidt:

When I wrote to you last year announcing the formation of a Political Action Committee for space, my research had failed to reveal the existence of an already formed Spacepac.

After speaking with one of their representatives, I have been informed that Spacepac has been an active organization for over six years. Its correct address is:

SPACEPAC
922 Pennsylvania Ave. Southeast
Washington, D.C. 20003

My Penn Yan address will not accept any contributions for Spacepac, and will return all such contributions to sender.

I suggest that those readers who believe in a political solution to space exploration support SPACEPAC.

ARTHUR J. AHRENS
Penn Yan, NY

Dear Dr. Schmidt,

As a longtime *Analog* reader, I've noticed Tom Easton's occasional potshots at L. Ron Hubbard. The most recent one (The Reference Library, Mid-December '88), has prompted me to write.

I have no quarrel with Mr. Easton's assessment of Hubbard's fiction. First of all, this is a matter of taste, as opposed to opinion or fact. (By the way, thank you for pointing out that distinc-

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tion in your recent editorial. I've found it useful many times already.) Second, it's a subject of which Mr. Easton definitely has first-hand knowledge—he's read the books!

But on the subject of Hubbard's "religion" (Easton's quotes), I'm afraid he's just plain wrong. The Scientologists I know do not tend to be suckers. In general, I've observed them to be leaders rather than followers, more intelligent and competent than the average, and often at or near the tops of their fields. And thousands of them, including myself, swear by the workability and usefulness of Hubbard's philosophies.

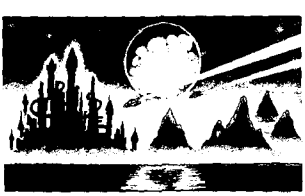
My guess is that Mr. Easton has largely based his opinion of Scientology on second-hand information (what he's read in the press or seen on TV), and the opinions and experiences of others. If this is the case, I'm sure he's aware of the distortions that can occur in the media ("tabloid TV" is an obvious example; there are subtler ones), and it is true that people who leave a church (or a job, for that matter) often do so because of their own minor or major crimes and later tend to criticize the organization to justify themselves. This is just a long-winded way of saying that one shouldn't base strong opinions on second-hand data. Mr. Easton should at least read a basic book on the subject before expressing his opinion again in print. I would suggest "A New Slant on Life," or "The Problems of Work." These books are available in many libraries.

If he has actually had a bad personal contact with Scientology, I wouldn't mind hearing about it. It may be no more than a misunderstanding, and he's missing out on some pretty interesting stuff.

In the meantime, your readers should know that there are other opinions about Scientology than Mr. Easton's, and that at least one person with first-hand knowledge thinks very highly of the subject.

GARY D. GARRETT

812 3rd Ave. N. #3
Seattle WA 98109



●I can't understand why a person would spend a year writing a novel when he can buy one for a few dollars.

Fred Allen

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a calendar of analog upcoming events

30 June-2 July
EMPIRICON '89 (NYC-area SF conference) at Holiday Inn Jetport, Elizabeth, N.J. SF Guests of Honor—Fred Pohl and Jack Williamson; Fantasy Guests of Honor— L. Sprague & Catherine Crook de Camp. Fan Guests of Honor—Sam Moskowitz and David Kyle. Registration—$20 until 1 June, $30 at the door. Info: Empiricon '89, Box 682, Church Street Station, New York NY 10008.

30 June-2 July
CONTEXT '89 (Alberta SF conference) at Lister Hall, University of Alberta, Edmonton, Alta., Canada. Guests of Honour — William Gibson, Charles de Lint; Artist Guests of Honour—Dianne and Leo Dillon; Science Guest of Honour—Brad Thompson. Registration—$20 in advance, $25 at the door. Info: Context '89, Box 4655 PSSE, Edmonton Alberta T6E 5G5 Canada. Include IRCs for response.

30 June-2 July
INCONJUNCTION IX (Indianapolis-area SF conference) at Adam's Mark Hotel, Indianapolis, Ind. Author Guest of Honor—Raymond E. Feist, Artist Guest of Honor—Dan Maitz, Fan Guest of Honor — Tony Ubelhor, TM—Joel Rosenberg. Registration—$20 until 15 June, $25 thereafter and at the door (children 7-11 half price). Info: InConJunction, Box 19776, Indianapolis IN 46219. Include S.A.S.E.

30 June-4 July
WESTERCON 42 (Western North America SF conference) at Marriott Hotel, Anaheim, Calif. Guest of Honor—John Varley, Fan Guest of Honor—Arthur Hlavaty. Registration $45 until 15 June. Info: SCI-FI, Westercon 42, Box 8442, Van Nuys CA 91409.

14-16 July
OKON '89 (Tulsa area SF conference) at Camelot Hotel, Tulsa, Okla. Guest of Honor—Robert Bloch, Artist Guest of Honor—David Mattingly, Fan Guest of Honor—Dr. David Govaker, TM—Steve Gould. Registration—$15 until 10 June, $20 at the door. Info: Okon '89, Box 4229, Tulsa OK 74159. (918)622-2225.

21-23 July
ARCHON 13 (St. Louis-area SF conference) at Henry VIII Inn, St. Louis, Mo. Guest of Honor—David Brin, Artist Guest of Honor—Frank Kelly Freas, Fan Guest of Honor—Julius Schwartz, TM—Wilson "Bob" Tucker. Registration—$18 until 1 June, $22 thereafter. Info: Archon 13, Box 50125, Clayton MO 63105. (314)421-2860.

28-30 July
RIVERCON 14 (Louisville area SF conference) at Louisville, Ky. Registration—$15 until 15 July, $20 at the door. Info: Rivercon 14, Box 58009, Louisville KY 40258.

31 August-4 September
NOREASCON III (47th World Science Fiction Convention) at Sheraton-Boston Hotel and Hynes Convention Center, Boston, Mass. Guests of Honor—Andre Norton, Ian & Betty Ballantine; Fan Guest of Honor—The Stranger Club (Boston's first SF club). Registration—$80 (adult), $50 (child) until 15 July. Supporting—$20 at all times. No advance memberships after 15 July 1989. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. *Info: Noreascon III, Box 46, MIT Branch,* Cambridge MA 02139.

—Anthony Lewis

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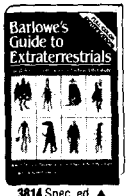

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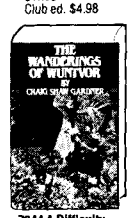

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